TABLES

FOR

FACILITATING THE APPROXIMATE PREDICTION

OF

OCCULTATIONS AND ECLIPSES

FOR ANY PARTICULAR PLACE.

BY

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PREFACE.

OCCULTATIONS of stars by the moon, observed under favourable circumstances, afford, in the opinion of the most competent authorities,* one of the best means of determining the absolute longitudes of terrestrial places; accurate observations of solar eclipses are also extremely valuable, both for this and other purposes; while, at the same time, both these phenomena are of considerable use in astronomy, in furnishing tests for verifying the accuracy or increasing the correctness of the Lunar Tables.

There is given annually, in the "Nautical Almanac," a list of all those stars to the fifth magnitude, inclusive, the occultations of which will be visible at any part of the earth, and also a table giving the elements of any solar eclipses which may occur. These tables contain much of the preliminary information† which will enable an observer to know beforehand whether any given occultation or eclipse will be visible at his particular station.

* See Raper "On Longitude;" Nautical Magazine, May 1840; also Baily's Tables and Formulæ, pp. 237, 278; Penny Cyclop. art. Longitude, vol. xiv. p. 143.

† It would add greatly to the convenience of the general Occultation Table, if, in addition to the information at present contained therein, two small columns could be added, giving for the time of true conjunction in right ascension the values of the moon's hourly motion in right ascension and declination, and in the case of a planetary occultation the relative values of those quantities. It would, perhaps, be sufficient to express these quantities in minutes of arc to the nearest tenth.

This alteration, in point of fact, would merely be a restoration of the Occultation Table in this particular to the form in which it was given in the "Nautical Almanac" for 1833, previous to the great alteration and improvement which commenced in 1834.

While speaking on the subject of the table given in the "Almanac," it may be as well to point out to the reader of these pages a seeming ambiguity which attaches to the use of the word *apparent*. In astronomical writings the word "apparent" is used as synonymous with "true," and in opposition to "mean;" whereas, in the sense in which it is used by the writers on navigation, it represents that visible

Observations, then, of this nature being of such acknowledged importance, and the expediency of inviting attention to them being so fully recognised by the arrangements in the national ephemeris above mentioned, whence does it arise that so few observations of this kind are made by officers or others employed on distant stations? The observation itself being at once extremely interesting, of great simplicity, and requiring for its accomplishment telescopes of little more than ordinary powers.

The answer will probably be found in the fact of the want of any practical work on the prediction of eclipses and occultations, giving, in a sufficiently popular form, the necessary directions for rendering available for any particular place the general information on the subject at present to be found in the tables given in the "Nautical Almanac."

Many of the writers on nautical astronomy and practical mathematics (Inman, Riddle, Raper, Galbraith), give rules in their treatises for determining the longitude from an observed occultation or solar eclipse; but they have not considered it necessary, as scarcely, perhaps, falling within the legitimate design of their works, to give any method for predicting their occurrence; and the information which will be found on this head in most works on astronomy* chiefly refers to the old method of the "nonagesimal," a laborious process, and ill-adapted to the present state of the "Nautical Almanac," where the places of the heavenly bodies are now given in right ascension and declination, instead of in latitude and longitude, as formerly in the old tables.

condition under which the heavenly phenomena actually appear to observers on the earth's surface, in contradistinction to their "true" appearances, under which they would present themselves if viewed from the earth's centre.

Thus we speak of apparent altitudes and apparent distances in opposition to true altitudes and true distances. Throughout these pages the word "apparent" is used in this latter sense, in which seamen in general are accustomed to understand it; and wherever it has been necessary to refer to the time of conjunction given in the table in the "Nautical Almanac," the word "apparent" in the heading of the column has been translated into its synonyme "true;" and in speaking of the appearances as affected by parallax, the words "as viewed by the spectator at the earth's surface" have usually been distinctly added, to prevent the possibility of misconception.

* See Woodhouse's "Astronomy," (ed. 1821), p. 738; Maddy's "Astronomy," (ed. 1832), p. 314; Francœur, "Astronomie Pratique," p. 303.

In the Appendix to the "Nautical Almanac" for 1836, will be found an able paper on Eclipses, by Mr. W. S. B. Woolhouse, in which the whole subject is fully treated, and convenient formulæ given for the performance of the necessary computations; and we are informed, in the annual Preface to the "Nautical Almanac," that the calculations of the Elements of Occultations, &c. therein given, are made in the manner described by Mr. Woolhouse in his treatise.

Sir John Lubbock has also entered into an elaborate mathematical investigation of the theory of eclipses;* but, from the nature of his design, it will not be found to afford much assistance to those who merely seek for practical information.

That eminent astronomer, the late Mr. Henderson, in a paper which will be found in the "Memoirs of the Astronomical Society,"† has explained the method pursued by him in predicting the occurrence of these phenomena; and to some of the ideas developed in that article the Author of these pages is in some degree indebted.

Although Mr. Woolhouse's formulæ leave nothing to be desired in point of accuracy and clearness, and are perfectly adapted to the present state of the "Nautical Almanac," yet it has occurred to the Author of these pages that, in cases where extreme precision is not required to suit the wants of the astronomer, the ordinary purposes of prediction might be attained with a much less amount of labour by the introduction of certain modifications, which, sacrificing something in point of accuracy, should gain greatly in the way of brevity and simplicity.

The principal method by which it is proposed to carry into effect these objects is by the use of auxiliary tables for the determination of the parallaxes, and by the introduction of the use of the Traverse Table; but the Author would wish it to be clearly understood that he lays no claim to absolute novelty of design in any part of this work, the method being avowedly based on the principle of that described by Mr. Woolhouse; and tables for the approximate determination of the parallaxes having been already proposed and partially carried into effect

* "Elementary Treatise on the Computation of Eclipses and Occultations." Charles Knight, London, 1835.

† See "Mem. Ast. Soc." vol. iv. No. xxxii, p. 587.

by Dr. Pearson, Sir John Lubbock, and Mr. Henderson,* while the application of the Traverse Table to facilitate the subordinate computations of astronomy has been clearly pointed out by the last-named distinguished astronomer in the paper before referred to.

The merit of the Author, if any merit there be, is principally confined to the reduction of these ideas to an organised system of arrangement, and to the labour of having computed the various tables necessary for carrying these principles into practical operation; and the Author trusts that he has succeeded by these means in bringing the problem of the prediction of an occultation or solar eclipse quite within the reach of any well-educated seaman who is conversant with the use of mathematical tables, and expert in the ordinary processes of navigation. It will be for the public and the naval profession to determine how far these efforts have been successful: and it is hoped that these endeavours will be received, if not with a favourable judgment, at any rate in a spirit of friendly criticism.

The work is divided into two parts. Part I. contains a mathematical explanation of the principles on which the rules and tables are founded, a tabular recapitulation of the formulæ and examples illustrating their application; and this part of the work, be it remembered, has been written, not for the mathematician or astronomer, but chiefly for the instruction of seamen, whose varied professional avocations afford them but little leisure for the acquirement of mathematical knowledge. This fact is necessary to be borne in mind, in order to account for homely observations and a general method of treating the subject, which might otherwise appear superfluous or impertinent.

Part II. contains, for the convenience of those who are unaccustomed to the use of formulæ, and in the habit of computing solely by means of verbal precepts, the rules for the performance of the necessary computations, arranged separately for Occultations and Eclipses, and illustrated in each case with numerous examples.

* See Pearson's "Practical Astronomy," (Zodiacal Tables); Lubbock on "Eclipses," Tables III. V. and VII. pp. 37–40; Henderson on the "Prediction of Occultations," "Mem. Ast. Soc." vol. iv. pp. 589, 593.

Considerable care has been bestowed on this part of the subject; and it is presumed that the varied nature of the examples which have been selected will be found fully to meet the practical wants of seamen in this respect.

The Diagrams illustrative of the various cases of Occultations and Eclipses offer another prominent feature in these pages; and the Author ventures to hope that they will be of considerable assistance to computers, not only as immediately teaching them to determine the proper application of the corrections, &c., but also as enabling them more easily to acquire an insight into the *rationale* of the process.

Those who are willing to take the rules on trust, and who merely desire to enter at once on the practical computations, may pass over Part I. and proceed at once to Part II., which, it is hoped, will be found to contain all that is sufficient for their purposes.

Lastly, follow the Tables with an explanation of their construction, use, and application. Among them will be found some which are not original, but common to almost all collections of mathematical tables; and these have been here inserted, in order to save the computer the necessity of referring to other books more frequently than necessary.

In conclusion, the Author trusts that the intelligent Seaman, by means of the facilities afforded to him by these pages, may frequently be enabled to contribute his share towards the gradual improvement of hydrography and the advancement of astronomical knowledge; and he further hopes that, although this work is principally intended for the members of his own profession, it may not be deemed altogether unworthy of the notice of the scientific Traveller or of the attention of the practical Astronomer.

Barn Elms, Surrey, March 1847.

ERRATA AND ADDENDA.

Page 10, line 4, *for* S *q* o_1, *read* S *q o*.
— —, — 5, *for* E M n_1, *read* E M *n*.
— 28, *for* At the time T, Green. Date, May 1st, &c. *read* May 15th.
— 33, *et seq*. It should have been distinctly pointed out in the rule for the prediction of an occultation, wherever the precept occurs, that, on entering the Traverse Table with the hour angle as a course, if the hour angle exceeds 6^h, the table is to be entered with its supplement, or what it wants of 12^h.
— 41. The diagram illustrating the occultation of ν *Aquarii*, at Raine's Island, is not correctly drawn; the arc V P′E ought to be about 159° instead of more than 180°, as at present. This leads us to observe that the diagrams attached to the examples are not in any case meant to be absolutely correct in their delineation of the values of the angles of inclination, &c., but only to exhibit a general approximation to the true circumstances of the case, some exaggeration being often absolutely necessary in order to render the figures plain. In the present case, however, these allowable limits have been somewhat inadvertently transgressed.
— 44, *for* Log. F. Tab. VI. *read* Log. F. Tab. V.
— —, right-hand side of the page, line 13 from bottom, *for* T′ $10^h\ 41^m{\cdot}5$, *read* T $10^h\ 41^m{\cdot}5$.
— 54, line 7 from bottom, *for* E S 16·8, *read* E S 16·3.
— 69, *for* Log. F. Tab. VI. *read* Log. F. Tab. V.

ON OCCULTATIONS,

&c. &c.

ON THE APPROXIMATE PREDICTION OF SOLAR ECLIPSES AND OCCULTATIONS OF THE PLANETS AND FIXED STARS BY THE MOON, FOR ANY PARTICULAR PLACE.

Introductory Observations.

THE method which we are about to explain in the following pages is a modification of that proposed by Mr. Woolhouse in his "Treatise on Eclipses," published in the Appendix to the "Nautical Almanac for 1836;" a work to which all who would wish to acquire a competent knowledge of the subject would do well to refer.

The general principles of Mr. Woolhouse's method may be briefly explained as follows:—

Having determined by a rough approximation the time of apparent conjunction in right ascension, as seen by the spectator at the earth's surface, he computes for that time the corrections for parallax in right ascension and declination, to be applied to the moon's true place to give her apparent place, and thus obtains the relative positions of the sun and moon at that epoch.

Assuming, then, that the moon's motion in her apparent orbit is equable throughout the duration of the eclipse, and that the small triangles formed by the arcs connecting the centres of the two bodies, the points of contact, &c. may be treated as rectilinear, and thus be brought within the familiar rules of plane trigonometry, he computes the necessary corrections to be applied to the assumed time for which the computations are made, and thus obtains the times of beginning, greatest phase, and ending.

When accurate results are required, the computations have to be repeated separately for beginning and ending, taking the times afforded by the first determination as new epochs on which to base the subsequent computations.

The modifications which we propose to introduce are as follows:—

First, by means of two auxiliary tables, based on Mr. Woolhouse's formulæ (see "Treatise, App. N. A. 1836," p. 116), and carrying into effect the same object as his small table at p. 129, to determine the time of apparent conjunction in right ascension with sufficient accuracy, so as to be able, without further alteration, to make that the starting point, to which the final corrections are to be referred.

This at once has the effect of rendering unnecessary in the subsequent computations any reference to the absolute right ascensions of the two bodies, and of reducing all the plane trigonometrical part of the process to cases of right-angled triangles, and thus enables us to avail ourselves of the use of the Traverse Table, by which a quantity of tedious computation is reduced to little more than the mere trouble of inspection.

Secondly, by means of a series of small tables, computed for every degree of latitude as well as specially for several particular places, and adjusted to the range of the moon's declination, the student can take out by inspection the principal elements for the determination of the parallaxes, and deduce from them the required quantities with very trifling labour, and nearly as accurately as by the usual logarithmic processes.

Thirdly, by means of a set of diagrams, illustrative of all the possible cases which can occur, the computer is enabled to see at once the way in which the corrections are to be applied, as well as the position of the points of contact. He is thus saved a great deal of uncertainty, and all necessity for paying attention to the algebraic signs of the various corrections is by these means in a great measure avoided.

Lastly, the rules for the necessary operations have been arranged verbally in a manner so plain and intelligible, that it is hoped that all persons conversant with the ordinary processes of navigation, or accustomed to the use of mathematical tables, will find them perfectly easy of comprehension.

Mr. Woolhouse, in his "Treatise," takes the case of solar eclipses first, and afterwards considers the case of occultations as a modification of them. It has appeared more convenient to the author, in the arrangement of the present treatise, to reverse this order of proceeding; and since occultations are phenomena of much more frequent occurrence than eclipses, and therefore of more practical use, to give the greater prominence to them, and afterwards to consider the case of solar eclipses as emanating from the same general principle.

It is obvious that it is allowable for us to choose either of these modes of proceeding which may appear most convenient, since, *mutatis mutandis*, the phenomena of solar eclipses and occultations of fixed stars by the moon are precisely analogous in their mathematical conditions.

PART I.

ON THE APPROXIMATE PREDICTION OF OCCULTATIONS OF THE FIXED STARS BY THE MOON FOR ANY PARTICULAR PLACE.

Notation.

1. THE notation used throughout the following pages, except where otherwise mentioned, is the same generally as that adopted by Mr. Woolhouse. (See "Appendix N. A. 1836," p. 76.)

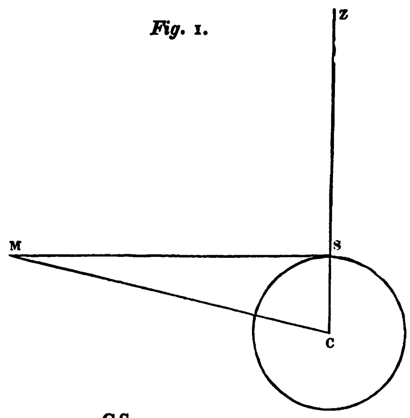
D = the moon's true declination.
δ = the star's declination.
α_1 = the moon's true hourly motion in right ascension.
D_1 = the moon's true hourly motion in declination.
P = the moon's equatorial horizontal parallax.
s = the moon's true semidiameter.
l = the geocentric latitude of the spectator.
h = the moon's true hour angle.
D' h' = the apparent values of D and h, as seen by the spectator at the earth's surface, or as affected by parallax.

OBSERVATION.—North latitude and declination, northerly motion in declination, west hour angles, and direct motion in right ascension, are reckoned +
Vice versâ, these several quantities are to be reckoned .... −

We will now proceed to investigate expressions for calculating at any time the moon's parallax in altitude, right ascension, and declination.

2. Let C (*Fig.* 1) be the centre of the earth; M the moon; CS the earth's equatorial radius; CM the distance from the moon to the earth's centre $= r$; SM the plane of the horizon to a spectator at S.

Fig. 1.



Then will the angle CMS or P represent the moon's equatorial horizontal parallax, and

$$\sin \text{CMS, or } \sin P = \frac{\text{CS}}{\text{CM}} = \frac{1}{r},$$

considering the earth's equatorial radius as unity, and for any other radius ϱ,

$$\sin P_1 = \frac{\varrho}{r},$$

$$\therefore \quad \frac{\sin P_1}{\sin P} = \frac{\frac{\varrho}{r}}{\frac{1}{r}} = \varrho,$$

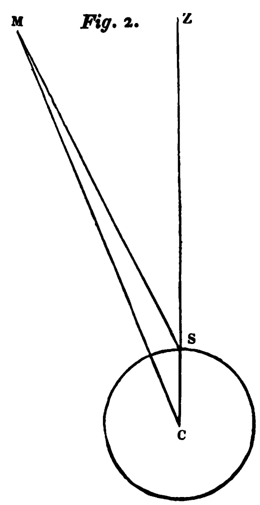
and $$\sin P_1 = \varrho \sin P, \qquad (1)$$

and substituting small arcs for their sines,

$$P_1 = \varrho P.$$

3. Let ZCM (*Fig.* 2) be the moon's true zenith distance, as seen from the earth's centre $=$ Z, and ZSM her apparent zenith distance, as seen by the spectator at the surface $= Z'$; also let SMC the parallax in altitude $= z$; and, as before, let CM $= r$ and CS $= \varrho$.

Fig. 2.



Then $$\varrho : r :: \sin z : \sin Z',$$

$$\therefore \quad \sin z = \varrho \sin Z' \cdot \frac{1}{r},$$

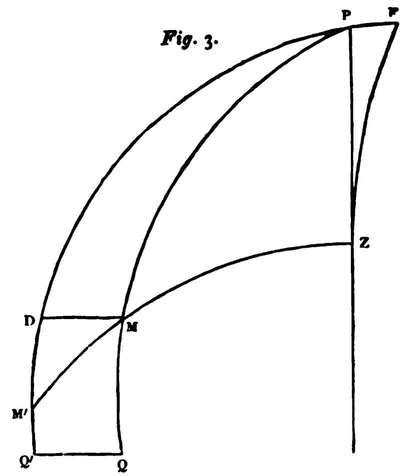
$$= \varrho \sin P \cdot \sin Z',$$

and $$z = \varrho P \cdot \sin Z', \quad (2)$$

which is the usual expression for the parallax in altitude.

4. Let P Z be a portion of the meridian; P the pole of the heavens; and Z the central zenith. M the moon's true place, as seen from the earth's centre; M′ her apparent place, as seen from the earth's surface, or as affected by parallax; P M Q and P M Q′ two circles of declination passing through the true and apparent places of the moon; Q Q′ the intercepted portion of the celestial equator.

Fig. 3.



Draw the parallel of declination M D.

Then will P Z be the colatitude of the observer.

Z P M the moon's true hour angle $= h$.

Z P M′ the moon's apparent hour angle $= h' = (h + \Delta\alpha)$.

Q M the true declination = D.

Q′M′ the apparent declination = D′.

Q′Q the measure of the angle M P M′, or $h' - h$, is the parallax in right ascension, or $\Delta\alpha = \frac{\text{D M}}{\cos \text{D}}$.

M M′ represents the parallax in altitude, and D M′ = D − D′ the parallax in declination, or Δ D.

The angle at M′ is called the parallactic angle (Mr. Woolhouse's M); and the small triangle M′ D M might with propriety be called the parallactic triangle, and being composed of small arcs, may moreover, whenever convenient, be treated as rectilinear.

Let Q′P be produced to F, and let F be taken so that M′F = 90°.

Draw the arc Z F.

Then $$\text{Q}'\text{Q} = \Delta\alpha = \frac{\text{D M}}{\cos \text{D}} = \frac{\text{M M}' . \sin \text{M}'}{\cos \text{D}},$$

but $$\text{M M}' = \varrho \text{P} . \sin \text{Z M}',$$

$$\therefore \quad \Delta\alpha = \frac{\varrho \text{P} \sin \text{Z M}' . \sin \text{M}'}{\cos \text{D}},$$

Now, in the triangle Z P M′,

$$\frac{\sin Z M'}{\sin P Z} = \frac{\sin h'}{\sin M'},$$

$$\therefore \quad \sin Z M' \sin M' = \sin P Z \sin h',$$

hence, by substitution,

$$\Delta \alpha = \frac{\varrho P \, . \cos l \sin h'}{\cos D}. \qquad (3)$$

Again $\quad D M' = \Delta D$ nearly $= M M' \cos M'$

$$= \varrho P \sin Z M' \, . \cos M'.$$

Now in the triangle Z M′ F,

$$\cos M' = \frac{\cos Z F - \cos Z M' \, . \cos M' F}{\sin Z M' \, . \sin M' F},$$

and since $M' F = 90°$.

$$\sin M' F = 1, \text{ and } \cos M' F = 0.$$

Hence $\quad \cos M' = \dfrac{\cos Z F}{\sin Z M'},$

$$\therefore \quad \sin Z M' \, . \cos M' = \cos Z F,$$

and, by substitution,

$$\Delta D = \varrho P \, . \cos Z F.$$

Again, in the triangle Z P F,

$$\cos Z P F = \frac{\cos Z F - \cos P Z \, . \cos P F}{\sin P Z \, . \sin P F},$$

$$\therefore \quad \cos Z F = \cos P Z \, . \cos P F + \sin P Z \sin P F \, . \cos Z P F.$$

Now, $\cos Z P F = -\cos Z P M'$, or $-\cos (h + \Delta \alpha)$,

therefore, by substitution,

$$\Delta D = \varrho P (\sin l \cos D' - \cos l \sin D' \cos (h + \Delta \alpha), \qquad (4)$$

We shall therefore have for the parallax of the hour angle, or right ascension, and that of the declination,

$$\Delta \alpha = \frac{\varrho P \cos l \sin h'}{\cos D}, \qquad (3)$$

$$\Delta D = \varrho P \, . (\sin l \cos D' - \cos l \sin D' \cos h'), \qquad (4)$$

which expressions, although not strictly accurate, are sufficiently so for the object we have in view, and afford us the means of determining approximately at any given time the apparent relative positions of the centre of the moon and the star.

5. In the computations that follow, it becomes necessary to determine what is the moon's apparent motion in her orbit, as seen by the spectator at the earth's surface.

The apparent motion in her orbit may be considered as the resultant of her two motions in right ascension and declination, which motions are subject to a constant variation, in consequence of the rapid change to which her hour angle is subject.

In order to determine the variation which takes place in the parallax, let us take the equations (3) and (4),

$$\Delta \alpha = \frac{\varrho P . \cos l \sin h'}{\cos D},$$

$$\Delta D = \varrho P . (\sin l \cos D' - \cos l \sin D' \cos h'),$$

and since the moon's true declination D can never differ much from her apparent declination D′, substitute the former for it in the above equation, and neglect $\Delta \alpha$ in the value of h, and we have

$$\Delta \alpha = \frac{\varrho P . \cos l \sin h}{\cos D},$$

$$\Delta D = \varrho P (\sin l \cos D - \cos l \sin D \cos h),$$

and since h is the only quantity in these expressions which, by its rapid variation, will sensibly affect their values, consider h as a variable and the other as constant quantities, and we have by differentiation,

$$\frac{d(\Delta \alpha)}{dt}, \text{ or } \Delta \alpha_1 = \left(\varrho P \frac{dh}{dt} . \sin 1''\right) \frac{\cos l}{\cos D} . \cos h,$$

$$\frac{d(\Delta D)}{dt}, \text{ or } \Delta D_1 = \left(\varrho P \frac{dh}{dt} . \sin 1''\right) \cos l \sin D \sin h,$$

Now $\frac{dh}{dt}$, or the hourly diurnal motion of the earth, is $15^\circ 2' 28''$, or $54148''$. Hence $\frac{dh}{dt} . \sin 1'' = [9{\cdot}41916]$.*

Therefore $\Delta \alpha_1 = \varrho P . [9{\cdot}41916] \frac{\cos l}{\cos D} . \cos h,$ (5)

$\Delta D_1 = \varrho P [9{\cdot}41916] \cos l \sin D \sin h,$ (6)

* When a logarithm is enclosed between brackets, as above, it means that the quantities with which it is combined are to be multiplied by the number of which it is the logarithm; and the object of this notation is to avoid ambiguity and the possibility of mistaking the logarithm for a natural number. Thus the expression

$$\sin A = 2 \cos B$$

might be otherwise written

$$\sin A = [0{\cdot}30103] \cos B.$$

and therefore for the moon's apparent hourly motions in right ascension and declination, we have

$$\left.\begin{array}{c}\text{Apparent hourly motion}\\ \text{in right ascension}\end{array}\right\} = (\alpha_1 - \Delta\,\alpha_1)\,.\,\cos D = y_1 \qquad (7)$$

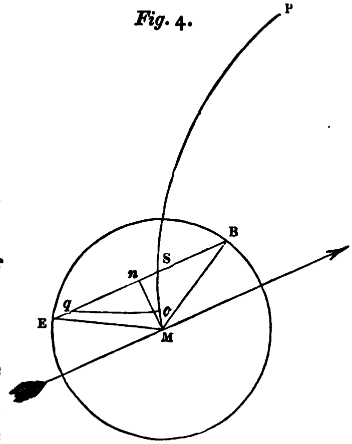
$$\left.\begin{array}{c}\text{Apparent hourly motion}\\ \text{in declination}\end{array}\right\} = D_1 - \Delta\,D_1 = x_1. \qquad (8)$$

The hourly motion in right ascension being reduced to the parallel of declination by multiplying it by cos D.

6. Now at the moment of apparent conjunction in right ascension, as seen by the spectator at the earth's surface.

Let M (*Fig.* 4) be the centre of the moon at the time of apparent conjunction in right ascension, and S the star; P S M the common circle of declination passing through the two bodies.

Fig. 4.



Let the arrowed line passing through M be the apparent path of the moon during the period of the occultation.

Let B be the point where the star enters the moon, and E the point where it emerges, then will the line B E represent the chord of the moon described by the star during the occultation, in an opposite direction to that of the moon's motion, such as it would appear to the spectator were the moon transparent.

In fact, it will be convenient to imagine, for the purpose of explanation, that during the occultation the moon remains stationary, and that her motion is transferred to the star only in an opposite direction, in which case the appearance to the spectator would obviously remain the same.

M B and M E are radii of the moon or her semidiameter $= s$.

Draw M n perpendicular to B E, then will n represent the point of nearest approach.

Let q be a point assumed such that the star with the moon's motion would take an hour in moving from S to q; draw the parallel of declination $q\,o$ intercepting the circle of declination P S M in o; then will Sq represent the moon's apparent hourly motion in her orbit, qo her apparent hourly motion in right ascension reduced to the parallel of declination or y_1, and So her apparent hourly motion in declination or x_1.

Call the angle nMS (= Sqo_1) ι,

and the angle BMn (= EMn_1) ω.

Also let $n\mathrm{M} = n$, and $n\mathrm{S} = m$,

and let SM, the apparent difference of declination of the moon and star = x.

Now Fig. 4 occupying so small a portion of the sphere, and being composed of small arcs, we may without sensible error treat them as straight lines; and since, moreover, the triangle BMn and EMn; and also qoS and SnM are, by construction, right-angled triangles, we plainly have

$$\tan \iota = \frac{x_1}{y_1}, \qquad (9)$$

$$\mathrm{M}n \text{ or } n = x \cos \iota, \quad (10) \qquad n\mathrm{S} \text{ or } m = x \sin \iota \quad (11)$$

$$q\mathrm{S} \text{ or } \left\{ \begin{matrix} \text{Hourly motion} \\ \text{in the orbit} \end{matrix} \right\} = \frac{y_1}{\cos \iota}, \qquad (12)$$

$$\cos \omega = \frac{n}{s} \quad (13) \qquad \mathrm{B}n \text{ or } \mathrm{E}n = s \,.\, \sin \omega, \quad (14)$$

$$\mathrm{BS} = \mathrm{B}n \pm m \qquad \mathrm{ES} = \mathrm{E}n \mp m.$$

Time of describing BS = BS divided by hourly motion in the orbit.

Time of describing ES = ES divided by hourly motion.

Which times applied with their proper signs (which may be seen by an inspection of the diagrams illustrative of the various cases) to the time of apparent conjunction in right ascension, when the star is at S, will give the times of beginning and ending.

7. We now come to consider how the time of apparent conjunction in right ascension is to be determined.

The time of true conjunction in right ascension between the moon and the star is given in the "Nautical Almanac:" call this time T.

Now at this time, since the bodies have no real difference of right ascension, it is clear that the apparent difference of right ascension, as viewed by the spectator at the earth's surface, is the parallax in right ascension or $\Delta\alpha$.

If, therefore, we divide the parallax in right ascension by the hourly motion at that time, we shall obtain the time of describing it, or the interval between T, the time of true conjunction in right ascension, and T′, the time of apparent conjunction.

Or $$t = \frac{\Delta\alpha}{\alpha_1 - \Delta\alpha_1}, \qquad (15)$$

in which t is expressed in units of an hour.

Or by substitution from equations (3) and (5),

$$t = \frac{\varrho P \cdot \frac{\cos l}{\cos D} \cdot \sin h}{\alpha_1 - \varrho P \cdot [9{\cdot}41916] \frac{\cos l}{\cos D} \cdot \cos h}, \qquad (16)$$

Or by reduction,

$$t = \frac{\sin h}{\alpha_1 \frac{\cos D}{\varrho P \cos l} - [9{\cdot}41916] \cdot \cos h}, \qquad (17)$$

and $T' = T + t$, in which t will have the same sign as the hour angle.

8. Having thus briefly explained the principles on which the process of calculation depends, it remains for us to consider what facilities can be afforded for approximate solution, by the aid of tables and other means, in cases where rigorous results are not sought for by the computer.

It has been shewn above that

$$T' = T + t,$$

where $$t = \frac{\sin h}{\alpha_1 \frac{\cos D}{\varrho P \cdot \cos l} - [9{\cdot}41916] \cos h},$$

t being expressed in units of an hour; multiplying the quantities on the right hand side of the equation by 100, in order to get rid of quantities wholly fractional, and expressing t in minutes of time, we have

$$t = \frac{6000 \cdot \sin h}{\alpha_1 \sec. l \left(\frac{100 \cdot \cos D}{P}\right) - [1{\cdot}41916] \cos h},$$

and making $$6000 \sin h = K,$$

$$\frac{100 \cdot \cos D}{P} = F,$$

$$[1{\cdot}41916] \cos h = N,$$

we have
$$t = \frac{K}{\alpha_1 \sec. l . F - N}, \qquad (18)$$
and
$$T' = T + t,$$

in which equation N will be negative when the hour angle is greater than 6^{hrs}, and the whole correction t will have the same sign as h.

Table V. contains the values of the logarithms of F for every minute of the moon's horizontal parallax and for every degree of her declination.

Table VI. contains the values of log. K and the natural number N for every minute of the moon's hour angle.*

Moreover, we may observe, referring to the original equation (15),

$$t = \frac{\Delta \alpha}{\alpha_1 - \Delta \alpha_1}.$$

That since, when the interval t is large, as is always the case when the moon is far from the meridian at the time of true conjunction, the $\Delta \alpha_1$ which depends upon the hour angle is subject to a rapid variation: it will be proper to adopt in the solution of the equation that value of $\Delta \alpha_1$ which corresponds to the middle of the interval t, or to the time $\frac{T+T'}{2}$.

It will be advisable, therefore, first to determine the value of t approximately, using that value of N in equation (18), which corresponds to h, the hour angle, at true conjunction, and afterwards to repeat the latter part of the process, taking a new value of N corresponding to the hour angle $h + \frac{t}{2}$. By this means a more correct result will be arrived at, and the time T′ be determined with considerable exactness.

The solution of the various expressions for the parallaxes may be effected partly by the use of auxiliary tables, partly by the use of the Traverse Table, "universally familiar to seamen."

For since the distance, difference of latitude, and departure in the Traverse Table correspond to the hypothenuse, base, and perpendicular of a right-angled triangle, whose base angle corresponds to the given course, it is obvious that all the relations involved in cases of right-angled triangles may be approximately

* When the hour angle exceeds 6^h the table is to be entered with the supplement of the hour angle, or what it wants of 12^h.

solved by its use. "In fact, it is a general proportional table," as Mr. Raper observes, "and many problems in proportion may be solved by it."*

To proceed: For the parallax in declination we have from equation (4),

$$\Delta D = \varrho P \cos l \,.\, \sin D' - \varrho P \,.\, \sin l \,.\, \cos D' \,.\, \cos h.$$

Assuming P at its mean value of 57′, and making

$$\varrho P \,.\, \cos l \,.\, \sin D' = A$$

$$\varrho P \,.\, \sin l \,.\, \cos D' = E,$$

we have

$$\Delta D = A - E \,.\, \cos h. \qquad (19)$$

Table VII. contains the value of the quantities A and E for every degree of latitude from the Equator up to 70°, and for every degree of the moon's declination; and Table VIII. contains the same quantities for several special places.

When the moon's horizontal parallax is other than 57′, the quantities A and E are to be reduced to their proper values by multiplying them by the factor $p = \frac{N}{57}$, where N = successively 53′, 54′, 55′, &c.; or the reduction may otherwise be more conveniently effected by taking out the required quantity by inspection from Table IX. which contains the values of A and E corresponding to every minute of the moon's horizontal parallax.

The multiplication of E by cos h is to be effected by the Traverse Table thus:—

With the moon's hour angle as a course, and E reduced in the distance column, enter the table, and the corresponding difference of latitude will be E cos h.

Again, from equations (5), (6), and (3),

$$\Delta \alpha_1 = \varrho P \,.\, [9{\cdot}41916] \frac{\cos l}{\cos D} \,.\, \cos h,$$

$$\Delta D_1 = \varrho P \, [9{\cdot}41916] \cos l \sin D \sin h,$$

$$\Delta \alpha = \frac{\varrho P \cos l \sin h}{\cos D}.$$

Now 9·41916 = log of 0·2625 = log of $\frac{1}{4}$ nearly.
Also let $\varrho P \,.\, \cos l = I$.

* See Raper's "Navigation," Explanation of Tables I. and II.

And, as before, ϱ P cos l sin D $=$ E, and we have

$$\Delta\,\alpha_1 \text{ red.} = \frac{\text{I} \,.\, \cos h}{4}, \qquad (20)$$

$$\Delta\,\text{D}_1 = \frac{\text{E} \,.\, \sin h}{4}, \qquad (21)$$

$$\Delta\,\alpha \text{ red.} = \text{I} \sin h. \qquad (22)$$

$\Delta\,\alpha_1$ and $\Delta\,\alpha$ being reduced to the parallel of declination by multiplying them by cos D; and, as before, solving these equations with the aid of the Traverse Table, we proceed as follows:—

First for equation (21): Enter the Traverse Table with E reduced as a distance and the moon's hour angle as a course, and take out the corresponding departure, which, divided by 4, will be Δ D_1 required.

Again, for equations (22) and (20), with the moon's hour angle as a course and I in the distance column, enter the Traverse Table.

The corresponding departure will be the $\Delta\,\alpha$, and the corresponding difference of latitude divided by 4, the $\Delta\,\alpha_1$ required.

The quantity I for every degree of latitude and for every minute of the moon's horizontal parallax will be found at the bottom of Table VII. and also for the special places at the bottom of Table VIII.

Then D the moon's true declination having been computed from the ephemeris for the time T′, and δ being the star's declination,

$$\text{D}' = \text{D} - \Delta\,\text{D},$$

difference of declination or $x = \text{D}' - \delta$.

Enter the Traverse Table with the moon's declination as a course, and α_1 in the distance column, the corresponding difference of latitude will be α_1 reduced.

Then $$y_1 = \alpha_1 \text{ red.} - \Delta\,\alpha_1 \text{ red.}$$

$$x_1 = \text{D}_1 - \Delta\,\text{D}_1.$$

Enter the Traverse Table with

y_1 in the diff. lat. column,

x_1 in the dep. column.

The corresponding course will be the angle ι, and the distance the apparent hourly motion in the orbit, which will have the same sign as x_1, the apparent motion in declination. At the same opening of the tables, with ι as a course and x the difference of declination in the distance column, the corresponding difference of latitude will be n, the nearest approach, and the corresponding departure the intercepted portion of the orbit m.

Lastly, with s as a distance and n as a difference of latitude, the corresponding course will be the angle ω, and the departure the intercepted portion of the orbit B n or E n.

$$BS = Bn \pm m, \text{ and } ES = En \mp m.$$

And B S and E S divided by the hourly motion = time of describing them, which times applied to T′ the time of apparent conjunction in right ascension, after the manner pointed out by the diagrams illustrative of the various circumstances of the case, will give the time of beginning and ending.

For the determination of the positions of the points of contact on the limb of the moon, it will be necessary to determine the value of the parallactic angle M′, which may be done as follows:—

Referring to the small triangle M′ D M, fig. 3, page 6,

$$\tan M' = \frac{DM}{DM'} = \frac{\Delta\alpha \text{ red.}}{\Delta D}.$$

Therefore, entering the Traverse Table with Δ D in the difference of latitude column, and $\Delta\alpha$ reduced as a departure, the corresponding course will be the parallactic M.*

The angles ω, ι, and M being then known, a brief consideration of the diagrams will at once point out the position of the points of immersion and emersion.

Planetary Occultations.

THE computation of the occultation of a planet may be performed in a precisely similar manner to that of the occultation of a fixed star; the only difference being, that it is sometimes necessary to take into account the hourly motions, semi-diameter,

* It may sometimes happen that the parallactic angle M will be greater than 90°, and this will be the case when the latitude is of the same name and less than the declination. In this case the parallactic angle taken from the Traverse Table is the supplement of the one to be used in the construction of the figure, and refers to the pole below the horizon, whereas the diagrams are always supposed to be constructed for the elevated pole.

and parallax of the planet; and for this purpose we must ma.. α_1 represent the relative motion of the moon and planet in right ascension, and D_1 their relative motion in declination.

And also use $s+\sigma$ instead of s, and $P-\pi$ instead of P, when necessary; σ and π respectively representing the semi-diameter and horizontal parallax of the planet.

Solar Eclipses.

MAKING, as in the case of a planetary occultation, α_1 and D_1 represent the relative motion of the two bodies, and using $s+\sigma$ and $P-\pi$ instead of s and P respectively, the computation of a solar eclipse might be performed in a similar manner to that of the occultation of a star.

The greater importance, however, of the phenomenon, and the rarity of its occurrence, make it worth while to adopt measures for obtaining a greater degree of accuracy in the results.

One of the principal sources of error in the determination of the time of beginning and ending of these phenomena arises from the erroneous assumption that the moon's motion in her apparent orbit is uniform throughout the duration of the occultation or eclipse.

This supposition in the case of an occultation may never introduce very serious error; but the case is otherwise with solar eclipses, which, *cæteris paribus*, will generally last rather more than about double the time of an occultation.

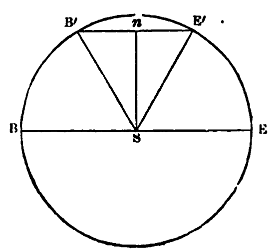
As a means, therefore, of obviating this source of error to a great extent, it will be convenient, after the determination of x, the difference of declinations, to alter the value of the hour angle h, shifting it backwards by half an hour for the beginning, and advancing it forwards half an hour for the ending, so as to obtain values of the hourly motion in each case separately, intermediately between the time of beginning and T′ in the one case, and between T′ and the time of ending in the other.

Of course the assumption of the two new values of the hour angle $h \pm 30^m$ is entirely arbitrary and depends upon the general consideration that the mean duration of a solar eclipse may be taken at about two hours; and, therefore, that the intervals between T′ and the time of beginning and ending will each be about one hour.*

The application of the corrections and the determination of the positions of the points of contact on the limb of the sun are to be determined in the same manner as in the case of an occultation, by a consideration of the diagrams illustrative of the various cases.

When the nearest approach, n, is less than the difference between the moon's augmented semidiameter and the sun's semidiameter, the eclipse will be total, when the moon's augmented semidiameter exceeds the sun's, and annular when the sun's semidiameter exceeds the moon's augmented semidiameter.

* It may be shewn that when x, the difference of declination, exceeds about $\frac{4}{5}$ of the sum of the semidiameters, it will be quite safe to proceed, as in the case of an occultation, without proceeding separately for beginning and ending, by altering the value of the hour angle.



For, in the annexed figure, let S be the centre of the sun, and B B′ E′ E be a fictitious disc surrounding it, whose radius S B = the sum of the semidiameters of the sun and moon.

Draw the diameter B E and also the chord B′ E′ parallel to it.

Then, in the case of a central eclipse, the phenomenon will commence when the moon's centre is at B and terminate when at E; and in the case of the partial eclipse, let it be supposed to commence when the moon's centre is at B′ and terminate when at E′.

And, supposing the velocities in the orbit to be the same in both cases, let the chord B′ E′ = $\frac{1}{2}$ B E; then will the partial eclipse exactly occupy half the time of the central one.

Draw the radius S B′ and also S n perpendicular to B′ E′; then making S B or S B′ = 1, B′ n = $\frac{1}{2}$, and we have

$$S n^2 = S B'^2 - B' n^2,$$
$$= 1 - (\tfrac{1}{2})^2,$$
$$= \frac{3}{4},$$
$$\therefore \quad S n = \frac{\sqrt{3}}{2},$$
$$= \frac{1{\cdot}732}{2} = 0{\cdot}866 = \frac{8}{10} \text{ nearly.}$$

Hence we see that when S n, the nearest approach, and therefore x, the difference of declinations, which never differs much from it, exceeds about $\frac{4}{5}$ of the sum of the semidiameters, the eclipse will only last half as long as if it were central, and might therefore be treated in point of computation in the same manner as the occultation of a star.

Otherwise, the eclipse will be partial.

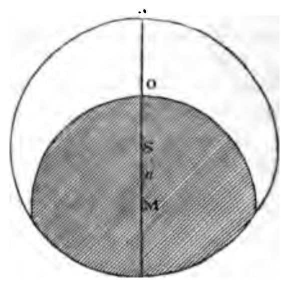
By making $\Delta' = (s + \text{aug.}) \sim \sigma$, the times of beginning and ending of the total or annular phases might be determined in the same manner as the partial phases; but the occurrence or otherwise of these peculiarities in the phenomena has such a delicate dependence on the accurate determination of the moon's relative parallax and the augmentation of her semidiameter, that the approximate method, which we are discussing in these pages, could not be depended upon, and might lead us to erroneous conclusions; and, therefore, if employed at all by the computer, it must be done with caution and judgment.

It may be, however, useful to remember that the greatest possible duration of an annular eclipse will rarely exceed six minutes, and that of a total eclipse three minutes and a half; so that as the period of greatest phase approaches, the observer may be prepared to look out for these phenomena, if the respective values of n, s, and σ give him reason to believe that either of these appearances is about to be exhibited.

For the determination of the magnitude of the partial phase,

Let *Fig.* 5 represent the relative appearance and position of the sun and moon at the moment of greatest phase.

Fig. 5.



Let S represent the centre of the sun and M that of the moon, then will $MS = n$, the nearest approach, and On be the illumined portion of the sun's diameter; and therefore $2\sigma - On$ will be the expression for the eclipsed portion of the disc in terms of the diameter. Now

$$
\begin{aligned}
\text{Eclipsed portion} &= 2\sigma - On \\
&= 2\sigma - (n + \sigma - s')^* \\
&= 2\sigma - n - \sigma + s' \\
&= \sigma + s' - n \\
&= \Delta' - n.
\end{aligned}
$$

And considering the sun's diameter as unity, we have

$$\text{Eclipsed portion} : 1 :: \Delta' - n : 2\sigma,$$

$$\therefore \quad \text{Eclipsed portion} = \frac{\Delta' - n}{2\sigma},$$

* s' representing the moon's augmented semidiameter.

which gives the magnitude of the eclipse in terms of the sun's diameter as unity.

We shall now proceed, after the manner of Mr. Woolhouse, to tabulate the formulæ, arranging them separately for occultations and eclipses, so as to simplify and expedite, by an easy reference, the actual operations of the computer.

Occultation of a Fixed Star by the Moon for any particular Place.

1. Local mean time T of true conjunction in Æ of ☽ and ✱ = Green. M.T. of ditto ± {Longitude in time} if East. / if West.

Find h the common hour angle of the moon and star at true conjunction.

$$h = \text{sidereal time at the place} - ✱\text{'s Æ}.$$

NOTE.— Sidereal time at the place = sidereal time at preceding Greenwich mean noon + local mean time + acceleration for the Greenwich date.

It will be sufficient to determine h to the nearest minute; mark it + or − as the case may be.

For the time T take from the "Nautical Almanac,"

P the moon's horizontal parallax } to the nearest tenth of
α_1 the moon's hourly motion in Æ } a minute of arc.
D the moon's declination to the nearest degree.

Correct the latitude for the earth's spheroidity by Table I.

Then $$t \text{ nearly} = \frac{K}{\alpha_1 \sec. l\, F - N}.$$

Log. F will be found in Table V. to arguments P and D.

Log. K and the number N in Table VI. to argument h, the moon's hour angle at true conjunction.*

Again $$t = \frac{K}{\alpha_1 \sec. l\,.\, F - N},$$

* When the hour angle exceeds 6^h, the table is to be entered with the supplement of the hour angle, or what it wants of 12^h.

in which, using the same values of K and F, as before, N is to be taken out for the hour angle $h + \frac{t}{2}$,

Then $T' = T + t$.

N will be positive when the hour angle is less than 6^h, negative when greater. The whole correction t will have the same sign as h.

2. Find a Greenwich date for the time T'; Greenwich date = Greenwich mean time of true conjunction + t, regard being paid to the algebraic sign of t.

Compute accurately from the ephemeris,

D the moon's declination, and take out by inspection
δ the star's declination.

Also
α_1 the moon's hourly motion in right ascension
D_1 the moon's hourly motion in declination
P the moon's horizontal parallax
s the moon's semidiameter
} to the nearest tenth of a minute of arc.

Also let h° the common hour angle of the moon and star at apparent conjunction = $h + t$.

3. Take out A and E by inspection from the Tables VII. or VIII.

If P be other than 57′ reduce A and E to their proper values by multiplying them by the factor p, or by inspection from Table IX.

Enter the Traverse Table with h° as a course and E in the distance column, the corresponding difference of latitude will be E . cos h°.

Mark A with the same sign as the latitude; and when the hour angle is less than 6^h, mark E . cos h° with the same sign as the declination, and with a contrary name when greater.

Then $\Delta D = A - E \cos h^\circ$.

$D' = D - \Delta D$.

And x, or difference of declination = $D' - \delta$.

If x much exceeds s, there will be no occultation; if nearly equal to it, it will be doubtful, either

Auxiliary Table, factor p, for correcting A and E.

Moon's H.P.	p
53′	0·93
53·5	0·94
54	0·95
54·5	0·96
55	0·96
55·5	0·97
56	0·98
56·5	0·99
57	1·00
57·5	1·01
58	1·02
58·5	1·03
59	1·04
59·5	1·04
60	1·05
60·5	1·06
61	1·07

not at all, or of very short duration; and if x is very small, the occultation will be nearly central.

4. Take out from the Tables VII. or VIII. the quantity I.

Enter the Traverse Table with h° as a course and E in the distance column; the corresponding departure divided by 4 will be ΔD_1.

Again, with h° as a course and I in the distance column.

The corresponding difference of latitude divided by 4 will be $\Delta \alpha_1$ reduced, and the departure $\Delta \alpha$ reduced.

5. Enter the Traverse Table with ΔD in the difference of latitude column, and $\Delta \alpha$ reduced as a departure; the corresponding course will be the parallactic angle M; which is to be taken out greater than 90° when the latitude is of the same name and less than the declination.

Again, with the moon's declination as a course and α_1 in the distance column, the corresponding difference of latitude will be α_1 reduced.

Then $$y_1 = \alpha_1 \text{ red.} - \Delta \alpha_1 \text{ red.}$$
$$x_1 = D_1 - \Delta D_1.$$

$\Delta \alpha_1$ reduced will be positive when the hour angle is less than 6^h; negative when greater.

ΔD_1 will be positive when the hour angle and declination have like names, negative when unlike.

6. Enter the Traverse Table with

y_1 as a diff. lat.
x_1 as a dep. } The corresponding course will be the angle ι, and the distance the hourly motion in the orbit.

Again, with

The angle ι as a course, and
x in the distance column } Corresponding diff. lat. will be n the nearest approach, and the dep. the intercepted portion of the orbit m.

Lastly, with

s in the dist. col. and
n as a diff. lat. } The corresponding course will be the angle ω, and the dep. the intercepted portion of the orbit Bn or En.

7. Then $BS = Bn \pm m$ and $ES = En \mp m$,

and

$$\left.\begin{array}{l} \dfrac{BS}{\text{H.M. in orbit}} = \text{time of describing it} \\ \dfrac{ES}{\text{H.M. in orbit}} = \text{time of describing it} \end{array}\right\} \text{in units of an hour.}$$

Draw a figure to represent the circumstances of the case (see diagrams), and it will at once appear how the corrections are to be applied to the time T′ to give the times of beginning and ending, and also how the angles ω, ι, and M are to be combined to give the position of the points of immersion and emersion on the limb of the moon, with reference to the pole and vertex.

Planetary Occultation.

Let α_{I} represent the relative hourly motion in right ascension of the moon and planet, or the motion of the moon — that of the planet.

And D_{I} the relative hourly motion in declination, or the motion of the moon — that of the planet.

Also, let δ be the planet's declination, σ its semidiameter, and π its horizontal parallax; and, when necessary, substitute $P-\pi$ for P, and $s+\sigma$ for s, and proceed as in the case of an occultation.

Solar Eclipse for any particular Place.

Let α_{I} and D_{I} represent the relative hourly motion of the sun and moon in right ascension and declination, or the motions of the moon — those of the sun.

Also, let δ be the sun's declination, σ its semidiameter, and π its horizontal parallax.

Use $P-\pi$ instead of P.

And $s+\sigma+0'{\cdot}2 = \Delta'$ instead of s, $0'{\cdot}2$ being added as a compensation for the mean value of the augmentation.

Find the local mean time T of true conjunction in right ascension by applying thereto the longitude in time.

And for the time T find h, the common hour angle of the sun and moon, by applying the approximate equation of time to it, and subtracting it from 24^h, if necessary.

Proceed to find T′ as in No. 1, and afterwards to find x the apparent difference of declination, as in 2 and 3.

If x much exceeds Δ' there will be no eclipse; if nearly equal the eclipse will be very partial, or not at all; and if x is very small the eclipse will be nearly central.

If x exceeds 25′ proceed with the subsequent computations as in Nos. 4, 5, 6, and 7, as in the case of an occultation, using Δ' instead of s.

If x is less than 25′ proceed as follows:—

For beginning, put back the hour angle, h°, by 30^m.

For ending, advance the hour angle, h°, by 30^m.

Call the new hour angles so obtained h_1 and h_2.

And proceed separately for the determination of the times of beginning and ending, as in Nos. 4, 5, 6, and 7, using the hour angles h_1 and h_2 respectively, instead of h°.

The time of greatest phase being determined from each computation, their accordance will, to a certain extent, be a a check on the accuracy of the computation.

For the position of the points of contact on the limb of the sun, the angles ι, ω, and M must be combined, as shewn by the diagrams illustrative of the various cases.

Magnitude of the eclipse $= \frac{\Delta' - n}{2\sigma}$; the sun's diameter being considered as unity.

Example, No. I.

REQUIRED the circumstances of the occultation of the star ι *Leonis* at Greenwich on January 7th, 1836.

	h m
Green. Mean Time of true Conj. in R.A.	12 12·3
Long. in Time	0 0
Local Mean Time or T.	12 12·3

	° ′
Lat.	51 28 N.
Red. Tab. I.	11
Red. Lat.	51 17

	h m
Sid. Time Green. Mean Noon	19 4·4
Local Mean Time	12 12·3
Acceleration for 12^h	2
Sid. Time	31 18·7
Star's R.A.	10 23·4
Star's Hour Angle	+20 55·3
	− 3 4·7

To find the Correction t.

At the time T.
(Green. Date, Jan. 7th, 12^h 12^m.)

$P = 56'$
$\alpha_1 = 122^s{\cdot}7 = 30'{\cdot}7$
$D = 15°$
$h = -3^h\ 5^m$

Log. α_1	1·4871
Log. Sec. Lat.	10·2038
Log. F. Tab. V.	0·2367
	1·9276 ...... 84′65
N. Table VI.	18·15
Difference	66·50

Log. K. Tab. VI.	3·6369
Log. 66·50	1·8228
	1·8141

t nearly $65^m{\cdot}18$

	h m
$\frac{1}{2}t$ =	0 33
h	3 5
$h + \frac{1}{2}t$	3 38

	84·65
N. Tab. VI.	15·24
Difference	69·41

	h m
h =	−3 5
t	−1 2
$h°$	−4 7

Log. K. Tab. VI.	3·6369
Log. 69·41	1·8414
	1·7955

$t = -62^m{\cdot}4$

	h m
T =	12 12·3
t =	−1 2·4
T′ =	11 9·9

At the time T′.
(Green. Date, Jan. 7th, 11^h 10^m.)

$P = 56'$
$s = 15{\cdot}3$
$\alpha_1 = +30{\cdot}7$
$D_1 = -11{\cdot}7$
$D = +15°45'\ 14''$
$\delta = +14\ 58\ 39$
$h° = -4^h\ 7^m$

	A.	E.
Tab. VIII.	42′9	9′2
Red. by Tab. IX.	42·1	9·0

	′
A	+42·1
E . cos $h°$	+ 4·2 From Traverse Table.
ΔD	+37·9

	° ′
D	+15 45·2
ΔD	+ 37·9
D′	+15 7·3
δ	+14 58·6
x	+ 8·7

$E = 9'\cdot0$ I. Table VIII. $34'\cdot9$

$\Delta D_1 = \frac{7'\cdot9}{4} = 2'\cdot0$ $\Delta\alpha_1$ red. $= \frac{16'\cdot4}{4} = 4'\cdot1$ $\Delta\alpha$ red. $= 30'\cdot8$

α_1 red.	$+29'\cdot6$		D_1	$-11'\cdot7$
$\Delta\alpha_1$ red.	$+\ 4\cdot1$		ΔD_1	$-\ 2\cdot0$
y_1	$+25\cdot5$		x_1	$-\ 9\cdot7$

Angle ι	$= 21°$	From the Traverse Table.
Hourly Motion in Orbit....	$= -27'3$	
n	$= 8\cdot1$	
m	$= 3\cdot1$	
B n or E n	$= 13\cdot0$	
Angle ω	$= 58°$	
Parallactic Angle M ...	$= 39$	

B n or E n.........	$13'0$	$\frac{16'1}{27\cdot3} = 0^{h}\cdot59 = 0^{h}\ 35^{m}\cdot4$
m	$3\cdot1$	
B S and E S	$16\cdot1$	$\frac{9'9}{27\cdot3} = 0^{h}\cdot36 = 0^{h}\ 21^{m}\cdot6$
	$9\cdot9$	

Figure to represent the circumstances of the case, same as Case IV. Moon east of meridian, centre to the northward of star, and motion in apparent orbit southerly.

	h m			h m
T'	11 9·9		T'	11 9·9
	21·6			35·4
Beginning	10 48·3		Ending	11 45·3

which results agree very nearly with Mr. Woolhouse's computation (see also "Nautical Almanac," 1836, p. 452).

For the positions of the points of contact, by combining the angles ι, ω, and M, we have for direct image

	For Beginning.	For Ending.
From North Pole	143° towards East.	101° towards West.
Vertex	178 towards Right.	62 towards Right.

to which 180° must be applied if they are required for the inverted image.

This is the same example as given by Mr. Woolhouse and Mr. Lubbock (see Woolhouse, on Eclipses, "Appendix, N. A." 1836, p. 145; Lubbock, on "Eclipses," p. 23.)

Example, No. II.

REQUIRED the circumstances of the occultation of the planet *Mars* at Port Essington, North Coast of Australia, on Feb. 1, 1845. (Latitude, 11° 7′ S.; Longitude, 132° 12′ E.)

	h m
Green. Mean Time of true Conj. in R.A.	11 42·4
Long. in Time, East	8 48·8
Local Mean Time or T	20 31·2

	° ′
Lat.	11 7 S.
Red. Tab. I.	4
Red. Lat.	11 3

	h m
Sid. Time Green. Mean Noon	20 46·2
Local Mean Time	20 31·2
Acceleration for $11^h 42^m$	1·9
Sid. Time	41 19·3
Planet's R.A.	16 25·2
Planet's Hour Angle	24 54·1
Or	+ 0 54

To find the Correction t.

At the time T.
(Green. Date, Feb. 1st, $11^h 42^m$.)

$P = 59'·6$
$\alpha_1 = 154^s - 7^s = 147^s = 36'·7$
$D = 21°$
$h = +0^h 54^m$

Log. α_1	1·5647
Log. Sec. Lat.	10·0081
Log. F. Tab. V.	0·1920
	1·7648 ...... 58′18
N. Table VI.	25·53
Difference	32·65

Log. K. Tab. VI.	3·1463
Log. 32·65	1·5139
	1·6324

Log. K. Tab. VI.	3·1463
Log. 33·32	1·5227
	1·6236

t nearly $= 42^m·89$

$\frac{1}{2} t = 0^h 21^m$
$h = 0\ 54$
$h + \frac{1}{2} t$ 1 15

	58·18
N. Tab. VI.	24·86
Difference	33·32

$t = +42^m·0$

T = $20^h 31^m·2$
t + 42
T′ = 21 13·2

$h = +0^h 54^m$
t + 42
$h°$ + 1 36

At the time T′.
(Green. Date, Feb. 1st, $12^h 24^m$.)

$P - \varpi = 59'6$
$s = 16·3$
$\alpha_1 = +36·7$
$D_1 = -2·2$
$D = -21° 10' 27''$
$\delta = -21\ 14\ 11$
$h° = +1^h 36^m$

	A.	E.
Tab. VII.	10′2	20′2
Red. by Tab. IX.	10·7	21·3

A −10′7
E . cos $h°$ −19·5 By Traverse Table.
ΔD + 8·8

D	$-21°$	$10'.5$
ΔD	+	8.8
D′	-21	19.3
δ	-21	14.2
x =	−	5.1

E = 21′.3 I. Table VII. = 58′.6

$\Delta D_1 = \frac{8'.7}{4} = 2'.2$ $\Delta \alpha_1$ red. $= \frac{53'.6}{4} = 13'.4$ $\Delta \alpha$ red. = 23′.8

α_1 red.	= +34′.2		D_1	=	$-2'.2$
$\Delta \alpha_1$ red.	= +13.4		ΔD_1	=	-2.2
y_1	= +20.8		x_1	=	0.0

Angle ι	= 0°	
Hourly Motion in Orbit	= 20′.8	From the Traverse Table.
n	= 5.1	
m	= 0.0	
Bn or En	= 15.6	
Angle ω	= 72°	
Parallactic Angle M ...	= 110	

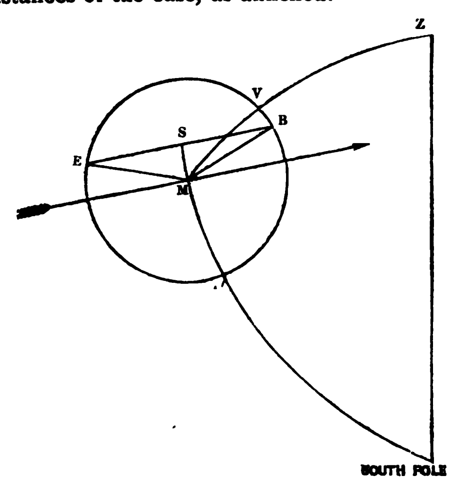
$\frac{15'.6}{20.8} = 0^{h}.75 = 0^{h}\, 45^{m}.0$

Figure to represent the circumstances of the case, as annexed.

Moon west of the meridian.
Centre to the southward of the planet.
And motion parallel to the equator.

	h m
T	21 13.2
	0 45.0
Beginning	20 28.2

	h m
T	21 13.2
	0 45.0
Ending	21 58.2



From North Pole	72° towards East.	72° towards West	For direct image.
From Vertex	2 towards Left.	142 towards Right	

At Port Essington, the immersion was observed by Capt. Blackwood, H. M. S. Fly, at $20^{h}\, 25^{m}\, 11^{s}.6$; hence the error of the prediction is $+3^{m}.0$. The emersion was not obtained.

Example, No. III.

REQUIRED the circumstances of the eclipse of the sun of May 15th, 1836, at Edinburgh.

	h m
Green. Mean Time of true Conj. in R.A.	2 21·4
Long. in Time, West..............	12·7
Local Mean Time T...............	2 8·7
Equation of Time	4
Sun's True Angle h	+2 13

	° ′
Lat.	55 57 N.
Red. Table I.	10
Red. Lat.	55 47

To find the Correction t.

At the time T.
(Green. Date, May, 1st, 2^h 21^m.)

$P-\pi = 54'3$
$\alpha_1 = 27'7$
$D = 19°$
$h = +2^h\ 13^m$

Log. α_1	1·4425	
Log Sec. Lat. ...	10·2500	
Log. F. Tab. V.	0·2408	
	1·9333	85·77
	N. Table VI.	21·95
	Difference	63·82

Log. K. Table VI.	3·5172
Log. 63·82	1·8050
	1·7122

t nearly $51^m{\cdot}55$

Log. K. Table VI..........	3·5172
Log. 65·59	1·8168
	1·7004

$t = +50^m{\cdot}17$

	h m
$\frac{1}{2}t$	0 26
h	2 13
$h+\frac{1}{2}t$	2 39

$h+\frac{1}{2}t$ 2 39 .... N. Tab. VI.

	85·77
N. Tab. VI.	20·18
	65·59

	h m
h =	+2 13
t	+ 50
h^o	+3 3

	h m
T =	2 8·7
t = +	50·2
T′ =	2 58·9

At the time T′.
(Green. Date, May 15th, 3^h 12^m.)

$P-\pi = 54'3$
$s = 14{\cdot}8$
$\sigma = 15{\cdot}8$
$\Delta' = s+\sigma+0'{\cdot}2 = 30'{\cdot}8$
$\alpha_1 = +27'7$
$D_1 = +\ 9{\cdot}4$
$D = +19°\ 33'\ 33''$
$\delta = +18\ 58\ 25$
$h^o = +3^h\ 3^m$

	A.	E.
Tab. VIII.	44′5	10′4
Red. by Tab. IX.	42·4	9·9

	′
A =	+42·4
E cos h^o	+ 6·9
ΔD	+35·5

	° ′
D =	+19 33·5
ΔD	+ 35·5
D′	+18 58·0
δ	+18 58·4
x	− 0·4

Computation for Beginning.

$$h^{\circ} + 3^{h}\ 3^{m}$$
$$30$$
$$h_1 + 2\ 33$$

$E = 9'{\cdot}9$ I. Table VIII. $= 30'{\cdot}5$

$\Delta D_1 = \frac{6'{\cdot}1}{4} = 1'{\cdot}5$ $\Delta\alpha_1$ red. $= \frac{24'}{4} = 6'{\cdot}0$ $\Delta\alpha$ red. $= 18'{\cdot}8$

α_1 red.	$+26'{\cdot}2$	D_1	$+9'{\cdot}4$
$\Delta\alpha_1$ red.	$+\ 6{\cdot}0$	ΔD_1	$+1{\cdot}5$
y_1	$+20{\cdot}2$	x_1	$+7{\cdot}9$

Angle ι	$= 21^{\circ}$	From the Traverse Table.
Hourly Motion in Orbit	$= +21'6$	
n	$= 0{\cdot}4$	
m	$= 0{\cdot}1$	
$M_1 n$	$= 30{\cdot}8$	
Angle ω	$= 89^{\circ}$	
Parallactic Angle M	$= 28$	

$M_1 n$	$30'8$
m	$0{\cdot}1$
$M_1 M$	$30{\cdot}7$

$$\frac{30'7}{21{\cdot}6} = 1^{h}{\cdot}421 = 1^{h}\ 25^{m}{\cdot}3$$

$$\frac{0'1}{21{\cdot}6} = 0^{h}{\cdot}005 = 0^{h}\ 0^{m}{\cdot}3$$

Figure to represent the circumstances of the case, same as Case V. Moon west of the meridian, to the southward of the sun, and motion in her orbit northerly.

	h m		h m
$T' =$	2 58·9	T'	2 58·9
	1 25·3		0·3
Begins	1 33·6	Greatest Phase	2 59·2

From North Pole 112° towards West } For direct
Vertex 140 towards West } image.

Computation for Ending.

$$h^{\circ} + 3^{h}\ 3^{m}$$
$$30$$
$$h_2 + 3\ 33$$

$E = 9'{\cdot}9$ I. Table VIII. $= 30'{\cdot}5$

$\Delta D_1 = \frac{7'{\cdot}9}{4} = 2'{\cdot}0$ $\Delta\alpha_1$ red. $= \frac{18'{\cdot}4}{4} = 4'{\cdot}6$ $\Delta\alpha$ red. $= 24'{\cdot}4$

α_1 red.	$+26'{\cdot}2$	D_1	$+9'{\cdot}4$
$\Delta\alpha_1$ red.	$+\ 4{\cdot}6$	ΔD_1	$+2{\cdot}0$
y_1	$+21{\cdot}6$	x_1	$+7{\cdot}4$

Angle ι	$= 19^{\circ}$	From the Traverse Table.
Hourly Motion in Orbit	$= +22'9$	
n	$= 0{\cdot}4$	
m	$= 0{\cdot}1$	
$M_2 n$	$= 30{\cdot}8$	
Angle ω	$= 89^{\circ}$	
Parallactic Angle M	$= 34$	

$M_2 n$	$30'8$
m	$0{\cdot}1$
$M_2 M$	$30{\cdot}9$

$$\frac{30'9}{22{\cdot}9} = 1{\cdot}35 = 1^{h}\ 21^{m}$$

	h m
T′ =	2 58·9
	1 21
Ends	4 19·9

From North Pole 72° towards East } For direct
Vertex 38 towards East } image.

Recapitulation.

Eclipse of the sun, May 15, 1836, at Edinburgh.

	h m		m	
Begins	1 33·6	Edinburgh Mean Time	+0·9	Errors on "Nautical Almanac."
Greatest Phase ...	2 59·2		+0·1	
Ends	4 19·9		+0·6	

See "Nautical Almanac," 1836, p. 469; also Woolhouse on Eclipses, "Appendix, N. A." 1836, p. 136; and Lubbock on Eclipses (Charles Knight, London, 1835), p. 26, where this eclipse will be found worked out at length by logarithms.

PART II.

WE shall now proceed to give, for the convenience of those unaccustomed to the use of formulæ, practical rules for the approximate prediction of occultations and eclipses, deduced from the principles which have been explained in the preceding pages, arranged separately for the two operations, and illustrated in each case by actual examples.

Occultations of Fixed Stars by the Moon.

Before we proceed to lay before the reader the rules for approximate prediction, it will be advisable to point out the general principles which must guide his choice in the selection from the general list given in the "Nautical Almanac" of cases for actual computation.

The Table of Elements for facilitating the computation of certain stars by the moon, given annually in the "Nautical Almanac," contains:—

1. The apparent places of those planets, and *all* stars to the fifth magnitude inclusive, the occultations of which will be visible at *some* part of the earth; and also of the stars to the sixth magnitude, the occultations of which will take place above the horizon at Greenwich.

2. The Greenwich mean time of true conjunction in right ascension, at which the moon would, if viewed from the centre of the earth, appear to have the same right ascension as the

star. These times being referable to the moon and star, as seen from the centre of the earth, are independent of geographical position, and serve equally for all places. It is only necessary to apply the difference of longitude from Greenwich to the Greenwich mean time of conjunction to find the time of conjunction at any other meridian, and it is this time to which the positions of the moon and star there given will equally correspond.

3. The difference of declination, and position of the moon as it would appear with respect to the star at the instant of conjunction in right ascension.

And lastly, the parallel of latitude, beyond which the star cannot *possibly* be occulted.

In preparing then from the general Table of Occultations, a list for any particular place, the computer must at once reject all those stars whose limiting parallels do not comprise the latitude of his position.

But it by no means follows, because his latitude is included within the parallels, that the occultation of the star will therefore be visible to him,—its visibility or otherwise depending on ulterior considerations. It may, however, be as well to observe, that even if his position in latitude be comprised within the limits, yet at the same time is nearly on the verge of either of them, although the occultation should finally prove to be visible to him, it can only be very partial, and will, therefore, be ill-adapted for the ultimate determination of the longitude, if that should be the object of the computer in preparing his list.

At the same time, the more centrally situated, the latitude of the computer is with reference to the limiting parallels, the greater will be the probability of the occultation being visible and central.

The next point to which attention must be directed is to consider whether, at the time of conjunction, the moon is above the horizon of the spectator.

To this end the local mean time of true conjunction must be determined by applying the longitude in time to the Greenwich time given in the table, and then by reference to the time of the moon's meridian passage and her semi-duration above the horizon, ascertain whether that time will include the period of occultation; recollecting, moreover, that the general effects of parallax will be to accelerate the occurrence of the occultation when the moon is east of the meridian, and to retard it when west; and that this acceleration or retardation may amount to as much as an hour and a half or more.

Supposing the moon to be above the horizon of the spectator, it must then be considered whether the intensity of sunlight would prevent the star being seen, which, when the phenomenon takes place in the daytime, will surely be the case, if the star is of small magnitude.

Lastly, if all these conditions are favourable, it must then be determined by special calculation, whether the effects of parallax will be such as to produce an occultation.

It appears, therefore, that four points must be considered in preparing an occultation list for any particular place.

First, the position of the place with reference to the limiting parallels of latitude.

Secondly, the presence of the moon and star above the horizon, at the time of apparent conjunction in right ascension.

Thirdly, favourable circumstances with reference to the intensity of daylight.

Lastly, the effects of parallax on the apparent relative positions of the moon and star.

Having made these preliminary observations, we shall now proceed to give a practical rule for the prediction of occultations.

Practical Rule for the Approximate Prediction of the Occultation of a Fixed Star by the Moon, for any particular Place.

1. Take out from the general table of elements in the "Nautical Almanac" the Greenwich mean time of true conjunction in right ascension of the moon and star, and applying* thereto the longitude in time, obtain the local mean time of that phenomenon, which call T.

* Add longitude in time, if East.
Subtract —— —— West.

For the time T, find the sidereal time at the place,* and from the sidereal time at the place, increased if necessary by 24^h, subtract the star's right ascension. The remainder, if less than 12^h, will be the star's hour angle, *h*, *West*, and if greater than 12^h, subtract it from 24^h, and the remainder will be the hour angle, *h*, *East*.†

For the time T take from the "Nautical Almanac,"

The moon's horizontal parallax to the nearest minute and tenth of a minute.‡

The moon's hourly motion in right ascension to the nearest minute and tenth of a minute of arc.§

The moon's declination to the nearest degree.

Reduce the latitude of the place by the correction for the earth's spheroidity by Table I.

Add together the logarithm‖ of the hourly motion in right ascension, the log secant of the reduced latitude, and log F from Table V. Reject the ten from the index of the sum, and find the natural number of the resulting logarithm, under which put the number N, corresponding to the hour angle, *h*, from Table VI.

If the hour angle is less than 6^h, take their difference, if greater their sum.

Subtract the logarithm of this difference or sum from the log. K, Table VI. corresponding to the hour angle *h*.

Find the natural number of the resulting logarithm, which will be the approximate value of the correction *t*, in minutes and decimals of a minute. Increase the hour angle *h* by half

* Sidereal time at the place = sidereal time at preceding Greenwich mean noon (from "Nautical Almanac") + local mean time + acceleration of sidereal time on mean time corresponding to the Greenwich date. (See "Table of Time Equivalents" in the "Nautical Almanac" for converting mean solar time into sidereal time.)

† See note (†), p. 35.

‡ The seconds of the moon's horizontal parallax are reduced to decimals of a minute, by dividing them by 6. Thus $55' \, 36'' = 55' \cdot 6$.

§ The moon's hourly motion in right ascension for any given date is to be determined by taking the difference between the values of the right ascension in the "Nautical Almanac" for the two consecutive hours which include the date, reducing it to seconds, and dividing by 4. Thus, suppose the difference $= 2^m \, 13^s \cdot 6$, then $2^m \, 13^s \cdot 6 = 133^s \cdot 6$, and $\frac{133 \cdot 6}{4} = 33' \cdot 4$.

‖ It will be sufficient to take out these logarithms to four places of decimals only.

the correction t (to the nearest minute), and take out a new value of N from Table VI. with the hour angle so increased.

If the new hour angle is less than 6^h, subtract N from the natural number before obtained; and, if greater, take their sum. Subtract the logarithm of this difference or sum from the log. K previously used.

The result will be the logarithm of the correction t in minutes of time.*

Under T the local mean time of true conjunction in right ascension, place t. If the hour angle is *West*, take their sum; if *East*, their difference: the result will be T′, the local mean time of apparent conjunction in right ascension, as seen by the spectator at the earth's surface.

Increase the hour angle h by the correction t, and call it the corrected hour angle.†

2. Find a Greenwich date for the time T′.

And for this date compute accurately from the ephemeris the moon's declination.

Take out also, by inspection, the star's declination (which will be found in the Table of Elements of Occultations).

Also the moon's horizontal parallax, semidiameter, hourly motion in right ascension, and hourly motion in declination,‡ to the nearest tenth of a minute of arc.

3. Take out A and E, by inspection, from Table VII. or VIII., interpolating between the terms when necessary.§

* See "Supplementary Observations."

† Since, by definition, at the time T, the moon and star have no *real* difference of right ascension; and at the time T′, by definition, they have no *apparent* difference of right ascension: the star's hour angle h, in the one case, and the corrected hour angle, in the other, will respectively represent the common hour angle of the moon and star at those times.

‡ The moon's hourly motion in declination for any given date is to be determined by taking the difference between the values of the declinations in the "Nautical Almanac" for the two consecutive hours which include the date, reducing the seconds to decimals of a minute by dividing them by 6, and marking the motion N or S, according as the moon is moving towards the north or south. Thus, supposing the difference between the two values of the declination is 7′ 25″, declination north and decreasing; then hourly motion in declination = 7′·4 S.

§ A and E, and also the quantity I, are expressed in minutes and decimals of a minute of arc; and it will be sufficient to take them out to the nearest tenth. The

If the moon's horizontal parallax is other than 57′, reduce A and E to their proper values by multiplying them by the factor p, or, by inspection, from Table IX.

Auxiliary Table, factor p, for correcting A and E.	
Moon's H.P.	p
53′	0·93
53·5	0·94
54	0·95
54·5	0·96
55	0·96
55·5	0·97
56	0·98
56·5	0·99
57	1·00
57·5	1·01
58	1·02
58·5	1·03
59	1·04
59·5	1·04
60	1·05
60·5	1·06
61	1·07

Enter the Traverse Table with the corrected hour angle as a course,* and E in the distance column; the corresponding difference of latitude will be E corrected.

Mark A, north or south, of the same name as the latitude.

And mark E corrected, north or south, of the same name as the moon's declination, when the hour angle is less than 6^h, and of a contrary name when greater than 6^h.

Under A place E corrected. If their names are alike, take their difference, which mark with their common name when E corrected is less than A, and with a contrary name when E corrected is greater than A.

When their names are unlike, take their sum, which will always have the same name as A.

The difference or sum thus found will be the moon's parallax in declination.

Place the parallax in declination under the moon's declination: if their names are alike, take their difference, which will have the same name as the declination when the declination is greatest, and a contrary name to the declination when the parallax in declination is the greatest.

If their names are unlike, take their sum, which will always have the same name as the moon's declination.

Call the result the moon's corrected declination.

Under the moon's corrected declination place the star's

only object in carrying them in the table to two places of decimals being for the convenience of interpolation. (See Explanation of Tables VII. and VIII.)

* If the argument, the course, in the Traverse Table is not given in time, as well as in degrees, the corrected hour angle must be reduced to degrees by first reducing it to minutes of time and then dividing by 4. Mr. Raper's Traverse Table, in which the argument, the course, is given very properly in time as well as in degrees, will be found particularly convenient for the computation of occultations by this method; and not only on this account, but also because the tables are arranged on the consecutive values of the degrees in the course as a base, instead of on the consecutive units of the distance, as in Dr. Inman's Tables.

declination: when their names are alike, take their difference; when unlike, their sum, which call the difference of declination. Mark the difference of declination north or south, according as the moon is north or south of the star.

If the difference of declination much exceeds the moon's semidiameter, there will be no occultation; if nearly equal to it, it will be doubtful, either not at all or of very brief duration; and if the difference of declination is very small, the occultation will be central, or nearly so.

4. Take out from the Table VII. or VIII. the quantity I.

Enter the Traverse Table with the corrected hour angle as a course, and E in the distance column: the corresponding departure divided by 4 will be the parallactic correction in declination.

Again, with the corrected hour angle as a course and I in the distance column, the corresponding difference of latitude divided by 4 will be the parallactic correction in right ascension, and the departure the parallax in right ascension.

Enter the Traverse Table with the moon's declination as a course, and her hourly motion in right ascension in the distance column: the corresponding difference of latitude will be the reduced hourly motion in right ascension.

Under the reduced hourly motion in right ascension place the parallactic correction in right ascension; when the hour angle is less than 6^h take their difference, when greater their sum: the result will be the apparent hourly motion in right ascension.

When the moon's declination is north and the hour angle west, or the declination south and the hour angle east, mark the parallactic correction in declination north, otherwise mark it south.

Place this correction, so marked, under the moon's hourly motion in declination. If their names are alike, take their difference, which mark with their common name if the parallactic correction in declination is less than the hourly motion in declination, but with a contrary name if greater. If their names are unlike, take their sum, which mark with the same name as the hourly motion in declination. Call the result the apparent hourly motion in declination.

5. Enter the Traverse Table with the apparent hourly motion in right ascension as a difference of latitude, and the apparent hourly motion in declination as a departure. The corresponding course will be the first angle of inclination* and the distance the hourly motion in the orbit, which mark with the same name as the apparent hourly motion in declination.

Again, with the first angle of inclination as a course, and the difference of declination in the distance column: the corresponding difference of latitude will be M *n*, the nearest approach, and the departure the intercepted portion of the orbit S *n*.

Lastly, with the moon's semidiameter in the distance column, and M *n*, the nearest approach, as a difference of latitude: the corresponding course will be the second angle of inclination,* and the departure the intercepted portion of the orbit B *n* or E *n*.

Moreover, with the parallax in declination as a difference of latitude and the parallax in right ascension as a departure: the corresponding course will be the parallactic angle M.*

Take the sum and difference of B *n* or E *n* and S *n*, the result will be B S or E S.

Divide B S and E S by the hourly motion in the orbit, the quotients will be the times of describing them in decimals of an hour, which multiply by 60, to reduce them to minutes and decimals of a minute, pointing off as many places in the product as there are in the multiplicand.

Consider the circumstances of the case, the moon's situation east or west of the meridian, her apparent position north or south of the star, and the direction of her motion in her apparent orbit, whether northerly or southerly, and turning to the Table of Diagrams, find under which case the circumstances fall.

A brief consideration of the figure will then at once shew how the corrections are to be applied to T′ to give the times of beginning and ending; and also how the angles of inclination and the parallactic angle are to be combined to give the

* The first angle of inclination is the angle S M *n*, in the diagrams; the second angle of inclination is the angle B M *n* or E M *n*; and the parallactic angle M is the angle P′ M V. (See diagrams illustrative of the various cases of occultations.)

positions of the points of contact on the limb of the moon, with reference to the pole and vertex.* These positions so determined will be for direct image. To obtain them as they would appear in an inverting telescope, 180° must be applied to them.

In the Greenwich List of Occultations given annually in the "Nautical Almanac," these angles are reckoned from the pole or vertex towards the *right* hand, round the circumference of the moon's limb, as seen in an inverting telescope.

* By the pole of the moon we mean that point in her circumference where a circle of declination passing through her centre intersects the limb, called north towards the north, and south towards the south.

By the vertex of the moon we mean that point on the upper part of her circumference where a circle of altitude, or a vertical circle passing through her centre, intersects the limb; that is, in point of fact, the highest point of the moon.

Example, No. I.

REQUIRED the circumstances of the occultation of the star ν *Aquarii* at Raine's Island, North East Coast of Australia, on July 2d, 1844. (Latitude, 11° 35′ S.; Longitude, 144° 6′ E.)

	h m
Green. Mean Time of true Conj. in R.A.	5 48·5
Long. in Time	9 36·4 E.
Local Mean Time or T.	15 24·9

	° ′
Lat.	11 35 S.
Red. Tab. I.	4
Red. Lat.	11 31 S.

	h m
Sid. Time Gr. Mean Noon	6 42·5
Local Mean Time	15 24·9
Acceleration for $5^h 48^m$	0·9
Sid. Time	22 8·3
Star's R.A.	21 1·2
Star's Hour Angle, *h*	1 7·1 W.

To find the Correction t.

At the time T.
(Green. Date, July 2d, $5^h 48^m$.)
Moon's Hor. Par. = 58′·6
— H.M. in R.A. = $134^s·7$ = 33′·7
— Declination = 12°

Log. H.M. in R.A.	1·5276
Log. Sec. Lat.	10·0088
Log. F. Tab. V.	0·2240
	1·7604

Log. K. Tab. VI.	3·2378		3·2378
Log. 32·46	1·5113	Log. 33·50	1·5250
	1·7265		1·7128

	57·60
N. Tab. VI.	25·14
	32·46
	57·60
N. Tab. VI.	24·10
	33·50

t nearly = 53·3 m

	h m
h	1 7
½ *t*	27
h + ½ *t*	1 34

t nearly 51·6 m

	h m
h	1 7 W.
t	52
Corr. Hour Angle	1 59 W.

	h m
T =	15 24·9
t	51·6
T′	16 16·5

At the time T′.
(Green. Date, July 2d, $6^h 40^m$.)

Moon's Decl.	12° 3′ 47″ S.
Star's Decl.	11 59 39 S.
Moon's Hor. Par.	58′·6
— Semid.	16·0
— H.M. in R.A.	$134^s·3$ = 33′·6
— H.M. in Decl.	11′·4 N.
Corr. Hour Angle	$1^h 59^m$ W.

	A.	E.
Tab. VII.	11′0	11′6
Red. by Tab. IX.	11·3	11·9

A.	11′·3 S.
E. corrected	10·3 S.
Moon's Par. in Decl.	1·0 S.

	° ′
Moon's Decl.	12 3·8 S.
Par. in Decl.	1·0 S.
Moon's Corr. Decl.	12 2·8 S.
Star's Decl.	11 59·7 S.
Diff. Decl.	3·1 S.

E = 11′·9 I. Table VII. = 57′·4

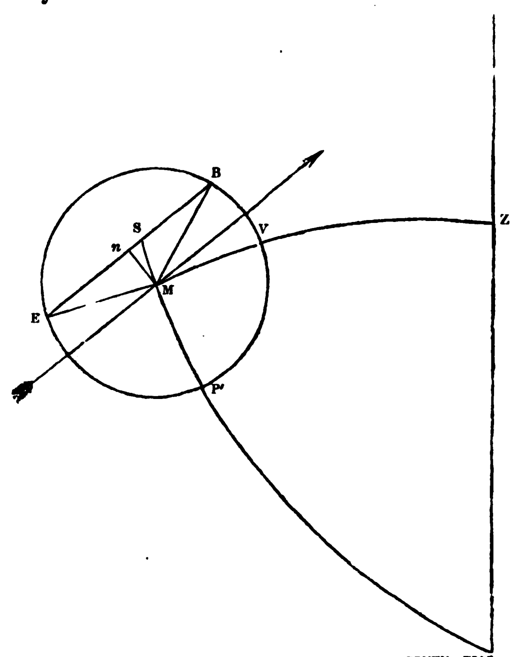
Par. Corr. in Decl. = $\frac{5'\cdot 9}{4}$ = 1′·5 Par. Corr. in R.A. = $\frac{49'\cdot 8}{4}$ = 12′·5

Par. in R.A. = 28′·7

Moon's Red. H.M. in R.A.	32′·9	Moon's H.M. in Decl.	11′·4 N.
Par. Corr. in R.A.	12·5	Par. Corr. in Decl.	1·5 S.
App. Hourly Motion in R.A.......	20·4	App. Hourly Motion in Decl.	12·9 N.

1st Angle of Inclination	32°	From the Traverse Table.
Hourly Motion in Orbit...............	24′ N.	
Nearest Approach, M *n*.............	2·6	
S *n*	1·6	
2d Angle of Inclination	81°	
B *n* or E *n*	15·8	
Parallactic Angle M	92°	

Figure to represent the circumstances of the case, same as Case V. Moon west of meridian, to the southward of the star, and motion in orbit northerly.



B *n* or E *n*	15′8
S *n*	1·6
B S	14·2
E S	17·4

$\frac{14'\cdot2}{24}$	$0^h\cdot59 - 0^h\ 35^m\cdot4$		$\frac{17'\cdot4}{24}$	$= 0^h\cdot725 = 0^h\ 43^m\cdot5$	
	T′	$16^h\ 16^m\cdot5$		T′	$16^h\ 16^m\cdot5$
		35·4			43·5
	Beginning	15 41·1		Ending	17 0·0

By observation at Raine's Island, the immersion took place at $15^h\ 40^m\ 15^s\cdot9$, and the emersion at $17^h\ 0^m\ 33^s$, Raine's Island mean time; hence the errors of the prediction are

For Immersion $+ 0^m\cdot8$, and for Emersion $- 0^m\cdot6$.

For the position of the points of immersion and emersion on the moon's limb, with reference to the vertex, we have, by combining the first and second angles of inclination and the parallactic angle M, as pointed out by the diagram,

At Beginning, from Vertex 39° towards Right; at Ending, 159° towards Left.

Example, No. II.

REQUIRED the circumstances of the occultation of the star *υ Leonis* at Greenwich, on March 2d, 1847.

	h m		h m
Green. Mean Time of true Conj. in R.A.	14 47·4	Sid. Time Gr. Mean Noon	22 38·6
Long. in Time...............	0 0	Local Mean Time...........	14 47·4
		Acceleration for $14^h\ 47^m$...	2·4
Local Mean Time T.	14 47·4	Sid. Time	37 28·4
		Star's R.A..................	11 29·2
Lat.	51° 28′ N.		25 59·2
Red. Tab. I.	11	Star's Hour Angle	1 59·2 W.
	51 17 N.		

To find the Correction t.

At the time T.

Green. Date, March 2d, $14^h\ 47^m$		Log. H.M. in R.A.	1·4472
Moon's Hor. Par.	53′·9	Log. Sec. Lat.	10·2038
— H.M in R.A....... $112^s\cdot2$ =	28′·0	Log. F. Tab. V............	0·2683
— Decl........................	1°		1·9193

Log. K. Tab. VI.......	3·4738	....	3·4738		83·04
Log. 60·25	1·7800	Log. 61·80 ...	1·7910	N. Tab. VI...	22·79
	1·6938		1·6828		60·25
	t nearly $49^m\cdot4$		$t = 48^m\cdot2$		
					83·04
				N. Tab. VI.	21·24
					61·80

	h m
h	1 59
$\frac{1}{2}t$	25
$h + \frac{1}{2}t$	2 24

	h m
h	1 59 W.
t	48
Corr. Hour Angle	2 47 W.

	h m
T	14 47·4
t	48·2
T′	15 35·6

At the time T′.

Green. Date, March 2d, $15^h\ 35^m$.

	° ′ ″
Moon's Decl.	0 41 1 N.
Star's Decl......................	0 1 0 N.

	A.	E.
Tab. VIII............	44′4	0′0
Red. by Tab. IX....	42·1	—

Moon's Hor. Par.	53′9
— Semid.	14·7
— H.M. in R.A..........	28·0
— H.M. in Decl..........	9·5 S.
Corr. Hour Angle	$2^h\ 47^m$ W.

	° ′
Moon's Decl............	0 41·0 N.
Par. in Decl.	42·1 N.
Moon's Corr. Decl.	0 1·1 S.
Star's Decl..............	0 1·0 N.
Diff. Decl.	0 2·1 S.

E = 0′·0 I. Tab. VIII. 33′·6

Par. Corr. in Decl. = 0′·0 Par. Corr. in R.A. = $\frac{24'\cdot9}{4}$ = 6′·2 Par. in R.A. = 22′·1

Moon's Red. H.M. in R.A.	28′0
Par. Corr. in R.A.	6·2
App. H.M. in R.A................	21·8

Moon's H.M. in Decl.	9′5 S.
Par. Corr. in Decl............	0·0
App. H.M. in Decl..........	9·5 S.

1st Angle of Inclination ...	23°	From the Traverse Table.
H.M. in Orbit....................	23′·7 S.	
Nearest approach M n	1·8	
S n...........	0·8	
2d Angle of Inclination ...	83°	
B n or E n	14′·6	
Par. Angle M.....................	28°	

Figure to represent the circumstances of the case, same as Case VII. Moon west of meridian, to the southward of the star, motion in orbit southerly.

B n or E n =	14′6
S n	0·8
B S	15·4
E S	13·8

$$\frac{15'\cdot4}{23\cdot7} = 0^h\cdot65 = 0^h\ 39^m\cdot0 \qquad \frac{13'\cdot8}{23\cdot7} = 0^h\cdot58 = 0^h\ 34^m\cdot8$$

	h m		h m
T′	15 35·6		15 35·6
	39·0		34·8
Beginning	14 56·6	Ending	16 10·4

Position of the points of immersion and emersion (for direct image),—

At Beginning from Vertex 78° towards Left or East.
At Ending from Vertex 88 towards Right or West.

which results agree very nearly with the "Nautical Almanac." (See "N. A." 1847, p. 527.)

Example, No. III.

Required the circumstances of the occultation of the star *τ Leonis* at Rio Janeiro, on March 18th, 1848. (Latitude, 22° 55′ S.; Longitude, 43° 9′ W.)

	h m
Green. Mean Time of true Conj. in R.A.	13 34·1
Long. in Time	2 52·6 W.
Local Mean Time T.	10 41·5

	° ′
Lat.	22 55 S.
Red. Tab. I.	8
Red. Lat.	22 47 S.

	h m
Sid. Time Green. Mean Noon	23 44·7
Local Mean Time	10 41·5
Acceleration for $13^h 34^m$	2·2
Sid. Time	34 28·4
Star's R.A.	11 20·1
	23 8·3
Star's Hour Angle *h*	0 52 E.

To find the Correction t.

At the Time T.
Green. Date, March 18th, $13^h 34^m$.
Moon's Hor. Par. .... 54′·6
— H.M. in R.A. = $115^s·6$ = 28′·9
— Decl. .... 3°

Log. H.M. in R.A.	1·4609
Log. Sec. Lat.	10·0353
Log. F. Tab. VI.	0·2630
	1·7592

Log. K. Tab. VI....	3·1302	....	3·1302
Log. 31·86	1·5032	Log. 32·51 ...	1·5120
	1·6270		1·6182

	57·44
N. Tab. VI. ...	25·58
	31·86
	57·44
N. Tab. VI. ...	24·93
	32·51

t nearly $42^m·4$ *t* = $41^m·5$

	h m
h =	0 52
½ *t*	21
h + ½ *t*	1 13

	h m
h	0 52 E.
t	41
Corr. Hour Angle...	1 33 E.

	h m
T′	10 41.5
t	41·5
T′	10 00·0

At the time T′.
Green. Date, March 18th, $12^h 53^m$.

Moon's Decl.	3° 18′ 2″ N.
Star's Decl.	3 41 20 N.
Moon's Hor. Par.	54′·6
— Semid.	14·9
— H.M. in R.A....	$115^s·7$ = 28′·9
— H.M. in Decl....	9′·3 S.
Corr. Hour Angle	$1^h 33^m$ E.

	A.	E.
Tab. VIII.	22′·0	3′·2
Red. by Tab. IX.	21·1	3·1

A	21′·1 S.
E. corr.	2·9 N.
Par. in Decl.	24·0 S.

	° ′
Moon's Decl.	3 18·0 N.
Par. in Decl.	24·0 S.
Moon's Corr. Decl.	3 42·0 N.
Star's Decl.	3 41·3 N.
Diff. Decl.	0·7 N.

$E = 3'.1$ I. Table VIII. $50'.2$

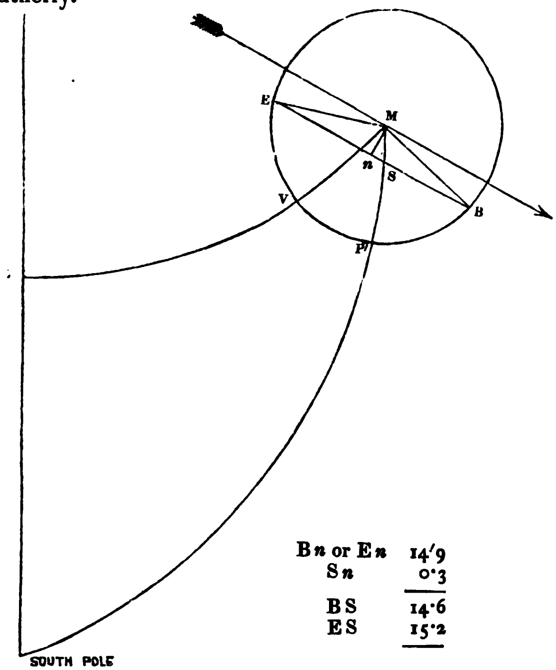
Par. Corr. in Decl. $= \frac{1'.2}{4} = 0'.3$ Par. Corr. in R.A. $= \frac{46'.2}{4} = 11'.5$

Par. in R.A. $= 19'.6$

Moon's Red. H.M. in R.A.	28'.9	Moon's H.M. in Decl.	9'.3 S.
Par. Corr. in R.A.	11.5	Par. Corr. in Decl.	0.3 S.
App. H.M. in R.A.	17.4	App. H.M. in Decl.	9.0 S.

1st Angle of Inclination. ...	27°	From the Traverse Table.
H.M. in Orbit	19'6 S.	
Nearest Approach M n....	0.6	
S n	0.3	
2d Angle of Inclination. ...	88°	
B n or E n	14'.9	
Par. Angle M	39°	

Figure to represent the circumstances of the case, same as Case IV. Moon east of meridian, to the northward of the star, and motion in orbit southerly.



B n or E n	14'9
S n	0.3
B S	14.6
E S	15.2

$\frac{14'.6}{19.6} = 0^h.745 = 0^h\ 44^m.7$ $\frac{15'.2}{19.6} = 0^h.775 = 0^h\ 46^m.5$

	h m		h m
T' =	10 0.0	T'	10 0.0
	44.7		46.5
Begins	9 15.3	Ends	10 46.5

At Beginning from Vertex 100° towards the Right or East.
At Ending —— 76 towards the Left or West.

Example, No. IV.

REQUIRED the circumstances of the occultation of the star ρ^1 *Sagittarii* at Malta, on the 24th April, 1848. (Latitude, 35° 54′ N.; Longitude, 14° 31′ E.)

	h m
Green. Mean Time of true Conj. in R.A.	14 53·9
Long. in Time	58·1 E.
Local Mean Time or T	15 52·0

	° ′
Lat.	35 54 N.
Red. Tab. I.	11
Red. Lat.	35 43 N.

	h m
Sid. Time Green. Mean Noon	2 10·6
Local Mean Time	15 52·0
Acceleration for $14^h\ 54^m$	2·4
Sid. Time	18 5·0
Star's R.A.	19 12·9
	22 52·1
Star's Hour Angle h	1 8 E

To find the Correction t.

At the time T.
Green. Date, April 24th, $14^h\ 54^m$.

Moon's Hor. Par.	56′·0
— H.M. in R.A.	$131^s·5$ = 32′·9
— Decl.	17°

Log. H.M. in R.A.	1·5172
Log. Sec. Lat.	10·0905
Log. F. Tab. V.	0·2324
	1·8401

Log. K. Tab. VI.	3·2441		3·2441		69·20
Log. 44·10	1·6444	Log. 44·86	1·6519	N. Tab. VI.	25·10
	1·5997		1·5922		44·10
	t nearly 40^m		t 39·1		69·20
				N. Tab. VI.	24·34
					44·86

	h m		h m		h m
h	1 8	h	1 8 E.	T	15 52·0
$\frac{1}{2}t$	20	t	39	t	39·1
$h + \frac{1}{2}t$	1 28	Corr. Hour Angle	1 47 E.	T′	15 12·9

At the time T′.
Green. Date, April 24th, $14^h\ 15^m$.

Moon's Decl.	17° 25′ 50″ S.
Star's Decl.	18 7 29 S.
Moon's Hor. Par.	56′0
— Semid.	15·3
— H.M. in R.A.	32·9
— H.M. in Decl.	3·1 N.
Corr. Hour Angle	$1^h\ 47^m$ E.

	A.	E.
Tab. VIII.	31′6	14′3
Red. by Tab. IX.	31·0	14·0

	′
A	31·0 N.
E. Corr.	12·5 S.
Par. in Decl.	43·5 N.

	° ′
Moon's Decl.	17 25·8 S.
Par. in Decl.	43·5 N.
Moon's Corr. Decl.	18 9·3 S.
Star's Decl.	18 7·5 S.
Diff. Decl.	1·8 S.

$E = 14'.0$ I. Table VIII. $45'{\cdot}4$

Par. Corr. in Decl. $= \frac{6'{\cdot}4}{4} = 1'{\cdot}6$ Par. Corr. in R.A. $= \frac{40'{\cdot}5}{4} = 10'{\cdot}1$

Par. in R.A. $= 20'{\cdot}6$

Moon's Red. H.M. in R.A.	$31'{\cdot}3$	Moon's H.M. in Decl.	$3'{\cdot}1$ N.
Par. Corr. in R.A.	$10{\cdot}1$	Par. Corr. in Decl.	$1{\cdot}6$ N.
App. H.M. in R.A.	$21{\cdot}2$	App. H.M. in Decl.	$1{\cdot}5$ N.

1st Angle of Inclination	4°	From the Traverse Table.
H.M. in Orbit	$21'{\cdot}3$ N.	
Nearest Approach M *n*	$1{\cdot}8$	
S *n*	$0{\cdot}1$	
2d Angle of Inclination	83°	
B *n* or E *n*	$15'{\cdot}2$	
Par. Angle M.	25°	

Figure to represent the circumstances of the case, same as Case VI. Moon east of meridian, to the southward of the star, and motion in orbit northerly.

B *n* or E *n*	$15'{\cdot}2$
S *n*	$0{\cdot}1$
B S	$15{\cdot}1$
E S	$15{\cdot}3$

$\frac{15'{\cdot}1}{21{\cdot}3} = 0^h{\cdot}709 = 0^h\ 42^m{\cdot}5$ $\frac{15'{\cdot}3}{21{\cdot}3} = 0^h{\cdot}718 = 0^h\ 43^m{\cdot}1$

	h m			h m
T′	15 12·9		T′	15 12·9
	42·5			43·1
Begins	14 30·4		Ends	15 56·0

At Beginning from Vertex 104° towards Left or East } For direct
At Ending —— 62 towards Right or West } image.

Example, No. V.

It may be useful to select an instance where the general probabilities would seem to point out the occurrence of an occultation, but where on trial, none is found to take place.

For this purpose we will take the case of *α Tauri,* on Sept. 28th, 1847, at Greenwich.

On referring to the general Occultation List, we see that the limiting parallels are 90° to 38° N. which include that of Greenwich.

True conjunction takes place at $14^h\ 58^m$ while the moon passes the meridian at $16^h\ 0^m$, consequently the moon will be above the horizon, and the intensity of daylight will not interfere with the visibility of the phenomenon.

We shall be justified, therefore, in commencing the calculation.

	h m
Green. Mean Time of true Conj. in R.A.	14 58·3
Long. in Time	0 0
Local Mean Time T....... ..	14 58·3
	° ′
Lat.	51 28 N.
Red. Tab. I.	11
Red. Lat.	51 17 N.

	h m
Sid. Time Green. Mean Noon	12 26·5
Local Mean Time...............	14 58·3
Acceleration for $14^h\ 58^m$......	2·5
Sid. Time	27 27·3
Star's R.A.	4 27·2
	23 0·1
Star's Hour Angle *h*	1 0 E.

To find the Correction t.

At the time T.
Green. Date, Sept. 28th, $14^h\ 58^m$.
Moon's Hor. Par. .... 59′
— H.M. in R.A.... $145^s{\cdot}4$ = 36′·4
— Decl. .... 17°

Log. H.M. in R.A.	1·5611
Log. Sec. Lat.	10·2038
Log. F. Tab. V.	0·2097
	1·9746

Log. K. Tab. VI....	3·1911	....	3·1911
Log. 68·98	1·8387	Log. 69·34 ...	1·8410
	1·3524		1·3501

	94·34
N. Tab. VI....	25·36
	68·98
	94·34
N. Tab. VI....	25
	69·34

t nearly $0^h\ 22^m$ *t* $0^h\ 22^m{\cdot}4$

	h m
h	1 0
$\frac{1}{2}t$	0 11
$h + \frac{1}{2}t$	1 11

	h m
h	1 0 E.
t	22
Corr. Hour Angle	1 22 E.

	h m
T	14 58·3
t	22·4
T′	14 35·9

At the time T′.
Green. Date, Sept. 28th, $14^h\ 36^m$.

Moon's Decl.	17° 9′ 41″ N.
Star's Decl.	16 11 51 N.
Moon's Hor. Par.	59′
— Semid.	16
— H.M. in R.A.	$145^s{\cdot}4$ = 36′·4
— H.M. in Decl.	3′·8 N.
Corr. Hour Angle......	$1^h\ 22^m$ E.

	A.	E.
Tab. VIII.............	42′6	10′0
Red. by Tab. IX. ...	44·1	10·3

A.	44′·1 N.
E. Corr.	9·6 N.
Moon's Par. in Decl.	34·5 N.

Moon's Decl.	17° 9′·7 N.
Par. in Decl.	34·5 N.
Moon's Corr. Decl.	16 35·2 N.
Star's Decl.	16 11·9 N.
Diff. Decl.	23·3 N.

Since the difference of declination much exceeds the semidiameter, it is clear that no occultation can take place. Continuing, however, the computation for the purpose of comparison with the "Nautical Almanac," we have

E = 10′·3 I. Table VIII. 36′·8

Par. Corr. in Decl. $= \frac{3'\cdot6}{4} = 0'\cdot9$ Par. Corr. in R.A. $= \frac{34'\cdot3}{4} = 8'\cdot6$

Par. in R.A. = 13′.2

Moon's Red. H.M. in R.A.	34′·8	Moon's H.M. in Decl.	3′·8 N.
Par. Corr. in R.A.	8·6	Par. Corr. in Decl.	0·9 S.
App. H.M. in R.A.	26·2	App. H.M. in Decl.	4·7 N.

1st Angle of Inclination...	10°	From the Traverse Table.
Hourly Motion in Orbit	26′6 N.	
Nearest Approach M*n*	23·0	
S*n*...........	4·0	
Par. Angle M	21°	

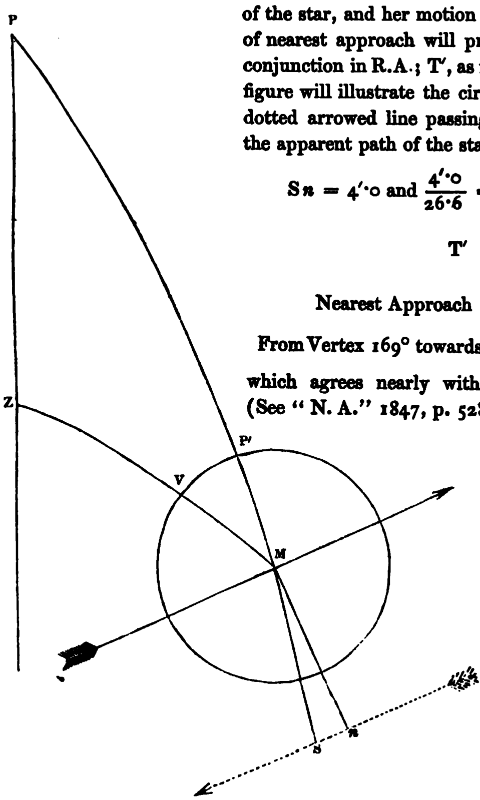
The moon being east of meridian, to the northward of the star, and her motion in orbit northerly, the time of nearest approach will precede the time of apparent conjunction in R.A.; T′, as in Case II.; and the annexed figure will illustrate the circumstances of the case; the dotted arrowed line passing through *n* S, representing the apparent path of the star past the moon's limb.

$$S n = 4'\cdot0 \text{ and } \frac{4'\cdot0}{26\cdot6} = 0^{h}\cdot15 = 0^{h}\, 9^{m}\cdot0$$

	h m
T′	14 36
	9
Nearest Approach	14 27

From Vertex 169° towards the Right for direct image.

which agrees nearly with the "Nautical Almanac." (See "N. A." 1847, p. 528.)



We shall conclude the Examples of the Computation of the Occultations of Fixed Stars, by giving one of a peculiar case, in which T′, the time of apparent conjunction in right ascension, is not included within the duration of the occultation, and in which the occultation did not commence until after the apparent conjunction in right ascension had taken place.

Example, No. VI.

REQUIRED the circumstances of the occultation of the star 75 *Virginis* at Greenwich, on the 12th of January, 1844.

	h m		h m	
Green. Mean Time of true Conj. in R.A.	14 14·1	Sid. Time Green. Mean Noon	19 24·4	
Long. in Time	0 0	Local Mean Time	14 14·1	
		Acceleration for $14^h\ 14^m$....	2·3	
Local Mean Time, T.	14 14·1	Sid. Time	33 40·8	
		Star's R.A.	13 24·5	
	° ′		20 16·3	
Lat.	51 28 N.	Star's Hour Angle *h*	3 44	E.
Red. Tab. I.	11			
Red. Lat.	51 17 N.			

To find the Correction t.

At the time T.
Green. Date, Jan. 12th, $14^h\ 14^m$.
Moon's Hor. Par. .... 59′·1
— H.M. in R.A. $137^s·3$ = 34′·3
— Decl. .... 14°

Log. H.M. in R.A.	1·5353
Log. Sec. Lat.	10·2079
Log. F. Tab. V.	0·2150
	1·9582

Log. K. Tab. VI....	3·6967	....	3·6967		90·82
Log. 76·14.........	1·8816	Log. 79·42 ...	1·8999	N. Tab. VI....	14·68
	1·8151		1·7968		76·14
	m		m		
t nearly	65·3	*t* =	62·6		90·82
				N. Tab. VI.......	11·40
					79·42

	h m		h m		h m
h	3 44	*h*	3 44 E.	T	14 14·1
½ *t*	33	*t*	1 3	*t*	1 2·6
h + ½ *t*	4 17	Corr. Hour Angle	4 47 E.	T′	13 11·5

At the time T′.
Green. Date, Jan. 12th, $13^h\ 12^m$.
Moon's Decl. .... 13° 28′ 43″S.
Star's Decl. .... 14 33 32 S.
Moon's Hor. Par. .... 59′1
— Semid. .... 16·1
— H.M. in R.A. $137^s·1$ = 34′·3
— H.M. in Decl.... 11′6 S.
Corr. Hour Angle......... $4^h\ 47^m$ E.

	A.	E.
Tab. VIII..................	43′0	8′8
Red. by Tab. IX..........	44·5	9·1

	′	
A	44·5	N.
E. Corr.	2·8	S.
Moon's Par. in Decl.	47·3	N.

Moon's Decl.	13° 28'·7	S.
Par. in Decl.	47·3	N.
Moon's Corr. Decl.	14 16·0	S.
Star's Decl.	14 33·5	S.
Diff. Decl.	17·5	N.

E = 9'·1 I. Tab. VIII. 36'·6

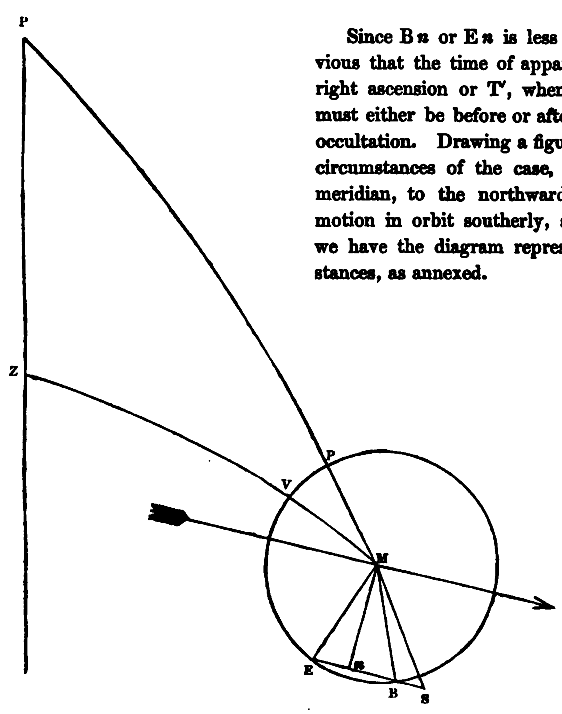
Par. Corr. in Decl. $\frac{8'\cdot6}{4} = 2'\cdot1$ Par. Corr. in R.A. $\frac{11'\cdot2}{4} = 2'\cdot8$

Par. in R.A. = 34'·8

Moon's Red. H.M. in R.A.	33'·1	Moon's H.M. in Decl.	11'·6 S.
Par. Corr. in R.A.	2·8	Par. Corr. in Decl.	2·1 N.
App. H.M. in R.A.	30·3	App. H.M. in Decl.	13·7 S.

1st Angle of Inclination	24°	From the Traverse Table.
H.M. in Orbit	33'·2 S.	
Nearest Approach M *n*	16·0	
S *n*	7·1	
2d Angle of Inclination	8°	
B *n* or E *n*	2'·2	
Par. Angle M	36°	

Since B *n* or E *n* is less than S *n*, it is obvious that the time of apparent conjunction in right ascension or ♈, when the star is at S, must either be before or after the period of the occultation. Drawing a figure to represent the circumstances of the case, moon east of the meridian, to the northward of the star, and motion in orbit southerly, similar to Case IV. we have the diagram representing the circumstances, as annexed.



From which it appears that the occultation did not commence until after apparent conjunction had taken place.

B*n* or E*n*	2′2
S*n*	7·1
BS	4·9
ES	9·3

and $\frac{4'\cdot9}{33\cdot2} = 0^{h}\cdot147 = 0^{h}\ 8^{m}\cdot8$ $\frac{9'\cdot3}{33\cdot2} = 0^{h}\cdot28 = 0^{h}\ 16^{m}\cdot8$

	h m		h m
T′	13 11·5	T′	13 11·5
	8·8		16·8
Begins	13 20·3	Ends	13 28·3

which results agree with those given in the "Nautical Almanac." (See "N. A." 1844, p. 522.)

For the positions of the points of contact, we have for direct image,—

At Beginning from Vertex 128° towards the Right.
Ending —— 112 —— ——

Planetary Occultations.

In the case of occultations of the planets it may occasionally be necessary to take into account the magnitude and motion of the planet; in which case the difference of the horizontal parallaxes of the moon and the planet is to be used instead of the moon's parallax alone, and the sum of the semidiameters instead of the moon's semidiameter alone.

Also, the relative hourly motions in right ascension and declination of the moon and planet are to be substituted instead of the absolute motions of the moon only.

The relative hourly motion in right ascension will be the difference of the hourly motions of the moon and planet, when the planet's motion is progressive, and their sum when retrograde.

The relative hourly motion in declination will be the difference of the motions of the moon and planet, when their names are alike, and their sum when unlike.

When the magnitude or motion of the planet is inconsiderable, these may be neglected, and the computation of the occultation may be made in all respects as for a fixed star.

Example, No. VII.

Required the circumstances of the occultation of the planet *Venus* at Port Royal, Jamaica, on the 12th of October, 1849. (Latitude, 17° 56′ N.; Longitude, 76° 51′ W.)

	h m		h m
Green. Mean Time of true Conj. in R.A.	23 18·6	Sid. Time Green. Mean Noon	13 23·8
Long. in Time	5 7·4 W.	Local Mean Time	18 11·2
		Acceleration for $23^h 18^m$	3·8
Local Mean Time, T	18 11·2	Sid. Time	31 38·8
		Star's R.A.	11 13·2
Lat.	17° 56′ N.	Star's Hour Angle, *h*	20 25·6
Red. Tab. I.	6	or	3 34·4 E.
Red. Lat.	17 50 N.		

To find the Correction t.

At the time T.
Green. Date, Oct. 12th, $23^h 18^m$.

Moon's Rel. Hor. Par.	57′4	Log. Rel. H.M. in R.A.	1·4669
— Rel. H.M. in R.A.	$128^s·5 - 11^s·4 = 117^s·1 = 29'·3$	Log. Sec. Lat.	10·0214
— Decl.	6°	Log. F. Tab. V.	0·2400
			1·7283
			53·50
		N. Tab. VI.	15.61
			37·89

Log. K. Tab. VI.	3·6833		3·6833		53·50
Log. 37·89	1·5785	Log. 44·31	1·6465	N. Tab. VI.	9·19
	2·1048		2·0368		44·31
	m		m		
t nearly =	127·3	*t*	108·8		

	h m
h	3 34
$\frac{1}{2}t$	1 4
$h+\frac{1}{2}t$	4 38

Since the second value of *t* differs so much from its first value, it will be advisable to make a second approximation for its more exact determination.* Hence

	h m				
h	3 34		53·50	Log. K. Tab. VI.	3·6833
$\frac{1}{2}t$	54	N. Tab. VI.	10·26		1·6359
$h+\frac{1}{2}t$	4 28		43·24		2·0474
				t	111·5

	h m		h m
h	3 34 E.	T	18 11·2
t	1 51·5	*t*	1 51·5
Corr. Hour Angle	5 25·5 E.	T′	16 19·7

* This is a case of very unfrequent occurrence, and for which it is impossible to lay down any general rule: it must, therefore, be left to the judgment of the computer. In the present case the omission of the second approximation would produce an alteration of $2^m·7$ in the value of *t*. A third approximation would scarcely have any further effect on the value of *t*, and would therefore be unnecessary.

At the time T′.

Green. Date, Oct. 12th, $21^h\ 27^m$.

Moon's Decl.	6° 45′ 22 N.	
Planet's Decl.	6 25 32 N.	
Moon's Rel. Hor. Par.	57′·4	
— — Semid.	15·8	
— — H.M. in R.A.	= 128s·4 — 11s·4 = 117s = 29′·2	
— — H.M. in Decl.	= 10′·3 — 1′·1 = 9′·2 S.	
Corr. Hour Angle	$5^h\ 25^m$ E.	

	A.	E.
Tab. VIII	17′3	6′o
Red. by Tab. IX	17·4	6·o

A	17′·4	N.
E. Corr.	0·9	N.
Moon's Par. in Decl.	16·5	N.

Moon's Decl.	6° 45′·4	N.
— Par. in Decl.	16·5	N.
— Corr. Decl.	6 28·9	N.
Star's Decl.	6 25·5	N.
Diff. Decl.	3·4	N.

E = 6′·o I. Tab. VIII. 54′·6

Par. Corr. in Decl. $= \frac{5'\cdot9}{4} = 1'\cdot5$ Par. Corr. in R.A. $= \frac{8'\cdot5}{4} = 2'\cdot1$

Par. in R.A. = 53′·9

Moon's Red. Rel. H.M. in R.A.	29′·o
Par. Corr. in R.A.	2·1
App. Rel. H.M. in R.A.	26·9

Moon's Rel. H.M. in Decl.	9′·2 S.
Par. Corr. in Decl.	1·5 S.
App. Rel. H.M. in Decl.	7·7 S.

1st Angle of Inclination	16°	From the Traverse Table.
Rel. Hourly Motion in Orbit	28′o S.	
Nearest Approach M n	3·2	
S n	0·9	
2d Angle of Inclination	78°	
B n or E n	15′4	
Parallactic Angle M	73°	

Figure to represent the circumstances of the case, same as Case IV. Moon east of meridian, to the northward of the planet, and motion in orbit southerly.

B n or E n	15′4
S n	0·9
BS	14·5
ES	16·8

$\frac{14'\cdot5}{28\cdot0} = 0^h\cdot518 = 0^h\ 31^m\cdot1$ $\frac{16'\cdot3}{28\cdot0} = 0^h\cdot582 = 0^h\ 34^m\cdot9$

	h m
T′	16 19·7
	0 31·1
Beginning	15 48·6

	h m
T′	16 19·7
	0 34·9
Ending	16 54·6

At Beginning from Vertex 169° towards the Right } For direct
Ending —— 13 towards the Right } image.

Example, No. VIII.

Required the circumstances of the occultation of the planet *Saturn* at the Cape of Good Hope, on Dec. 22d, 1849. (Latitude, 33° 56′ S.; Longitude, $1^h\ 13^m{\cdot}9$ E.)

In this case the motions of the planet in right ascension and declination being inconsiderable, as well as its semidiameter and horizontal parallax, the computation may be made in all respects as for a fixed star.

	h m
Green. Mean Time of true Conj. in R.A.	8 13·1
Long. in Time................	1 13·9 E.
Local Mean Time or T.....	9 27·0
	° ′
Lat.	33 56 S.
Red. Tab. I.......	10
Red. Lat.........	33 46 S.

	h m
Sid. Time Green. Mean Noon	18 3·7
Local Mean Time	9 27·0
Acceleration for $8^h\ 13^m$	1·3
Sid. Time	27 32·0
Planet's R.A.	0 9·3
Planet's Hour Angle *h*	3 22·7 W.

To find the Correction t.

At the time T.
Green. Date, Dec. 22d, $8^h\ 13^m$.
Moon's Hor. Par............. 56′·5
— H.M. in R.A.... $121^s{\cdot}5$ = 30′·4
— Decl. .... 2°

Log. H.M. in R.A.	1·4829
Log. Sec. Lat.	10·0802
Log. F. Tab. V.	0·2480
	1·8111

Log. K. Tab. VI.......	3·6671	....	3·6671		64·73
Log. 48·12	1·6823	Log. 52·71 ...	1·7219	N. Tab. VI. ...	16·61
	1·9848		1·9452		48·12
	t nearly $96^m{\cdot}6$		$t = 88^m{\cdot}1$		64·73
				N. Tab. VI....	12·02
					52·71

	h m		h m		h m
h	3 23	*h*	3 22·7 W.	T	9 27·0
$\frac{1}{2}t$	48	*t*	1 28·1	*t*	1 28·1
$h + \frac{1}{2}t$	4 11	Corr. Hour Angle	4 50·8 W.	T′	10 55·1

At the time T′.
Green. Date, Dec. 22d, $9^h\ 41^m$.
Moon's Decl. .... 2° 1′ 18″ S.
Planet's Decl................ 1 37 54 S.
Moon's Hor. Par. .... 56′5
— Semid. .... 15·4
— H.M. in R.A. $121^s{\cdot}6$ = 30′·4
— H.M. in Decl. ... 10′7 N.
Corr. Hour Angle......... $4^h\ 51^m$ W.

	A.	E.
Tab. VIII.	31′6	1′2
Red. Tab. IX..........	31·3	1·2

A	31′·3 S.
E. Corr.	0·3 S.
Moon's Par. in Decl.	31·0 S.

	° ′
Moon's Decl.	2 1·3 S.
Par. in Decl.	31·0 S.
Moon's Corr. Decl..........	1 30·3 S.
Planet's Decl.................	1 37·9 S.
Diff. Decl.	7·6 N.

$E = 1'{\cdot}3$ I. Table VIII. $46'{\cdot}9$

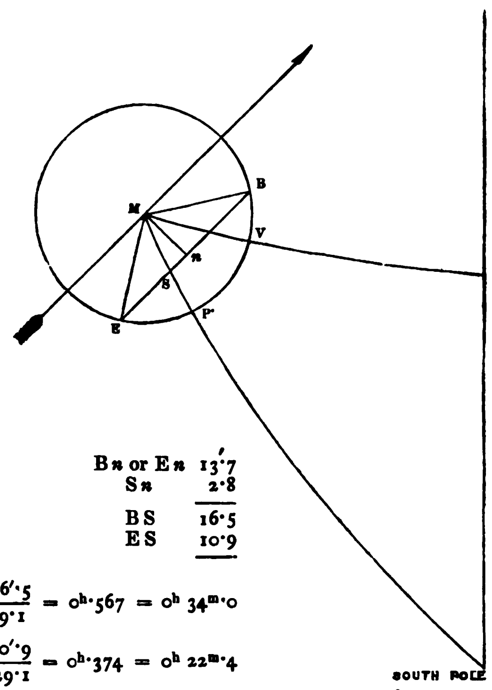
Par. Corr. in Decl. $= \frac{1'{\cdot}2}{4} = 0'{\cdot}3$ Par. Corr. in R.A. $\frac{13'{\cdot}6}{4} = 3'{\cdot}4$

Par. in R.A. $= 44'{\cdot}8$.

Moon's Red. H.M. in R.A.	$30'{\cdot}4$	Moon's H.M. in Decl.	$10'{\cdot}7$ N.
Par. Corr. in R.A.	$3{\cdot}4$	Par. Corr. in Decl.	$0{\cdot}3$ S.
App. H.M. in R.A.	$27{\cdot}0$	App. H.M. in Decl.	$11{\cdot}0$ N.

1st Angle of Inclination	22°	From the Traverse Table.
H.M. in Orbit	$29'{\cdot}1$ N.	
Nearest Approach M*n*	$7{\cdot}0$	
S*n*	$2{\cdot}8$	
2d Angle of Inclination	63°	
B*n* or E*n*	$13{\cdot}7$	
Par. Angle M	55°	

Figure to represent the circumstances of the case, same as Case I. Moon west of meridian, to the northward of the planet, and motion in orbit northerly.



B*n* or E*n*	$13'{\cdot}7$
S*n*	$2{\cdot}8$
BS	$16{\cdot}5$
ES	$10{\cdot}9$

$$\frac{16'{\cdot}5}{29{\cdot}1} = 0^h{\cdot}567 = 0^h\ 34^m{\cdot}0$$

$$\frac{10'{\cdot}9}{29{\cdot}1} = 0^h{\cdot}374 = 0^h\ 22^m{\cdot}4$$

	h m		h m
T′	10 55·1	T′	10 55·1
	0 34·0		0 22·4
Begins	10 21·1	Ends	11 17·5

At Beginning from Vertex 30° towards Right or East } for direct
Ending —— 96 towards Left or West } image.

Solar Eclipses.

There is given annually in the "Nautical Almanac" a diagram representing the path of the moon's penumbra over that portion of the earth's surface to which any given solar eclipse will be visible.

The computer who is about to undertake the calculation of a solar eclipse for any particular place must first satisfy himself, by an inspection of the diagram, that the eclipse will be visible at the place for which he proposes to make the prediction.

It will be useless to commence the computation for any place whose geographical position is not included within the boundary line of the figure. To all places exterior to the boundary line, the eclipse will be invisible; and the nearer any place within the boundary line approaches to the line of simple contact, the more partial will the phase of the eclipse be; and, on the contrary, the more nearly it approaches to the path of the central eclipse, the greater will be the magnitude of the eclipse to the observer.

The general mode of performing the computation will be similar to that already described in the case of the occultation of a star, the magnitude and motion of the sun introducing some modifications.

Instead of the absolute values of the moon's horizontal parallax, semidiameter, hourly motion in right ascension, and hourly motion in declination, substitute the relative values of those quantities, viz. the difference between the horizontal parallaxes of the sun and moon, the sum of their semidiameters, the difference of their hourly motions in right ascension, and the difference or sum of their hourly motions in declination, their difference being used when their motions have the same name, and their sum when their names are unlike.

Also, the sum of the semidiameters is to be increased by $0'\cdot2$, as a compensation for the mean value of the augmentation of the moon's semidiameter. Call the sum of the semidiameters so increased the distance of the centres.* Substitute also the sun's declination for that of the star.

Practical Rule for the Approximate Prediction of a Solar Eclipse for any particular Place.

1. TAKE from the Table of Elements of the Eclipses of the Sun, given in the "Nautical Almanac," the Greenwich mean time of true conjunction in right ascension of the sun and moon, and applying thereto the longitude in time, obtain the local mean time of that phenomenon, which call T.

For the time T find the corresponding apparent time, by applying thereto the equation of time taken approximately from the "Nautical Almanac."

The apparent time, so obtained, if less than 12^h, will be the sun's true angle, h, *West;* if greater than 12^h, subtract it from 24^h, and mark it *East.*

Correct the latitude by the reduction from Table I.

Proceed as in No. 1, in the case of an occultation, to find the correction t;† and thence T′, the time of apparent conjunction in right ascension, as seen by the spectator at the earth's surface; and also the corrected hour angle.‡

2. Find a Greenwich date for the time T′.

And for this date compute accurately from the ephemeris the sun and moon's declination.

Take out also, by inspection, to the nearest tenth of a

* The distance of the centres so obtained will be for the partial phase, for total or annular phase; the difference between the moon's augmented semidiameter and the sun's semidiameter must be used; but for the reasons given in Part I. p. 18, the computation for annular or total phase, if made at all, must be made with great caution, or the computer may be led to erroneous conclusions.

† See Supplementary Observations.

‡ The sun's hour angle h at the time T, and the corrected hour angle at the time T′, respectively represent the common hour angle of the sun and moon at those times, for the reasons given in note (†), p. 35.

minute of arc, the relative horizontal parallax of the sun and moon; their relative hourly motion in right ascension; and relative hourly motion in declination; and find the distance of the centres, as directed above.

3. Proceed as in No. 3, in the case of an occultation, to find the moon's parallax in declination, and thence the difference of declination.

If the difference of declination much exceeds the distance of the centres, there will be no eclipse; if nearly equal, the eclipse will be doubtful, either very partial or not at all; and if the difference of declination is very small, the eclipse will be central, or nearly so.

4. If the difference of declination exceeds 25′, proceed as in Nos. 4 and 5, in the case of an occultation, to find the apparent relative hourly motion in right ascension and declination; and then from the Traverse Table the first and second angles of inclination, the parallactic angle M, the nearest approach S *n*,* and the portions of the orbit $M_1 n$, or $M_2 n$, and M *n*, and then aided by the diagrams illustrating the various cases of eclipses, find the corrections to be applied to the time T′ of apparent conjunction in right ascension, to give the times of beginning, greatest phase, and ending, and also the position of the points of contact on the limb of the sun, with reference to its pole and vertex.

5. If the difference of declination is less than 25′, it will be necessary, in order to obtain more accurate results, to proceed separately, for beginning and ending as follows:—

For beginning, put back the corrected hour angle by 30^m; that is, decrease it when west, and increase it when east.

For ending, advance the corrected hour angle by 30^m; that is, increase it when west, and decrease it when east; and with the new hour angle, so obtained, proceed separately, as in Nos. 4 and 5, in the case of an occultation, to find the time

* The nearest approach S *n* and the portions of the orbit $M_1 n$, or $M_2 n$, and M *n*, in the case of an eclipse, respectively correspond to M *n*, B *n*, or E *n*, and S *n*, in the case of an occultation, as will at once appear on referring to the diagrams.

of beginning and greatest phase, in the one case, and the time of ending and greatest phase in the other.

The coincidence of the times of greatest phase by the two operations will, to a certain extent, afford a test of the accuracy of the work.

The positions of the points of contact on the limb of the sun will easily be seen on an inspection of the diagrams.

For the magnitude of the eclipse, take the difference between the distance of the centres and the nearest approach, and divide it by twice the sun's semidiameter; the quotient will be the magnitude of the eclipse, considering the sun's diameter as unity, on the northern or southern limb, according as the difference of declination is north or south.

Example, No. I.

REQUIRED the circumstances of the eclipse of the Sun, on July 7th, 1842, at Marseilles. (Latitude, 43° 17′ N.; Longitude, 5° 22′ E.)

	h m			° ′
Green. Mean Time of true Conj. in R.A.	18 54·8		Latitude	43 17 N.
Long. in Time	0 21·5 E.		Red. Tab. I............	11
Local Mean Time T..........	19 16·3		Red. Lat.	43 6 N.
Eq. Time	4·5			
	19 11·8			
Sun's Hour Angle *h*	4 48·2 E.			

To find the Correction t.

At the time T.		Log. Rel. H.M. in R.A.	1·5587
Green. Date, July 7th, 18h 55m.		Log. Sec. Lat.	10·1366
Moon's Rel. Hor. Par.	59′8	Log. F. Tab. V.	0·1870
— Rel. H.M. in R.A.	36·2		
— Decl.	23°		1·8823

Log. K. Tab. VI.	3·7564	....	3·7564		76·26
Log. 68·15	1·8335	Log. 72·83 ...	1·8623	N. Tab. VI....	8·11
	1·9229		1·8941		68·15
	t nearly 83m·8		*t* 78m 4		76·26
				N. Tab. VI.......	3·43
					72·83

	h m		h m		h m
h	4 48	h	4 48·2 E.	T	19 16·3
$\frac{1}{2}t$	42	t	1 18·4	t	1 18·4
$h+\frac{1}{2}t$	5 30	Corr. Hour Angle	6 6·6 E.	T′	17 57·9

At the time T′.

Green. Date, July 7th, 17h 36m.	
Moon's Decl.	23° 11′ 53″ N.
Sun's Decl.	22 32 56 N.
Moon's Rel. Hor. Par.	59′8
— Rel. H.M. in R.A.	36·3
— Rel. H.M. in Decl.	7·0 S.
— Semid.	16·3
Sun's Semid.	15·8
Distance of Centres	32·3
Corr. Hour Angle	6h 7m E.

	A.	E.
Tab. VII	35′9	15′9
Red. by Tab. IX.	37·8	16·7

A	37′8 N
E. Corr.	0·6 S.
Par. in Decl.	38·4 N.

Moon's Decl.	23° 11′9 N.
Par. in Decl.	38·4 N.
Moon's Corr. Decl.	22 33·5 N.
Sun's Decl.	22 32·9 N.
Diff. Decl.	0 0·6 N.

Computation for Beginning.

	h m
Corr. Hour Angle	6 7 E.
	30
New Hour Angle	6 37 E.

E = 16′·7 I. Tab. VII. 43′·7

Par. Corr. in Decl. $= \frac{16'\cdot5}{4} = 4'\cdot1$ Par. Corr. in R.A. $= \frac{6'\cdot8}{4} = 1'\cdot7$

Par. in R.A. = 43′·2

Moon's Red. Rel. H.M. in R.A.	33′4
Par. Corr. in R.A.	1·7
Moon's App. Rel. H.M. in R.A.	35·1

Moon's Rel. H.M. in Decl.	7′0 S.
Par. Corr. in Decl.	4·1 S.
Moon's App. Rel. H.M. in Decl.	2·9 S.

1st Angle of Inclination	5°	From the Traverse Table.
Rel. H.M. in Orbit	35′2 S.	
Nearest Approach S n	0·6	
M n	0·0	
2d Angle of Inclination	90°	
$M_1 n$	32′3	
Par. Angle M	49°	

Figure to represent the circumstances of the case, same as Case IV. Moon east of meridian, to the northward of the sun, and motion in orbit southerly.

$$\frac{32'3}{35\cdot2} = 0^h\cdot917 = 0^h\ 55^m\cdot0$$

	h m		h m
T′	17 57·9		17 57·9
	55·0		0·0
Beginning	17 2·9	Greatest Phase	17 57·9

Computation for Ending.

	h m
Corr. Hour Angle	6 7 E.
	30
New Hour Angle	5 37 E.

E = 16′·7 I. Tab. VII. 43′·7

Par. Corr. in Decl. $= \frac{16'\cdot6}{4} = 4'\cdot1$ Par. Corr. in R.A. $= \frac{4'\cdot6}{4} = 1'\cdot1$

Par. in R.A. = 43′·5

	′		′	
Moon's Red. Rel. H.M. in R.A....	33·4	Moon's Rel. H.M. in Decl.	7·0	S.
Par. Corr. in R.A....................	1·1	Par. Corr. in Decl................	4·1	S.
App. Rel. H.M. in R.A.............	32·3	App. Rel. H.M. in Decl.	2·9	S.

1st Angle of Inclination	5°	From the Traverse Table.
Rel. H.M. in Orbit................	32′4 S.	
Nearest Approach S n	0·6	
M n	0·0	
2d Angle of Inclination......	90°	
$M_2 n$	32·3	
Par. Angle M.........................	49°	

$$\frac{32'3}{32\cdot4} = 0^h\cdot997 = 0^h\ 59^m\cdot8$$

	h m
T′	17 57·9
	59·8
Ending	18 57·7

Recapitulation.

Eclipse of the sun, July 7th, 1842, at Marseilles.

	h m	
Begins............	17 2·9	Mean Time at Marseilles.
Greatest Phase	17 57·9	
Ends	18 57·7	

Comparing these results with the prediction given in the "Annuaire pour l'an 1842," p. 642, published by Le Bureau des Longitudes, at Paris, it appears that the errors of the approximate prediction are, for beginning $-0^m\cdot2$; for greatest phase $+0^m\cdot1$; and for ending $+0\cdot5$.

For the magnitude of the eclipse, we have,—

$$\text{Magnitude} = \frac{32'\cdot3 - 0'\cdot6}{31\cdot6} = \frac{31\cdot7}{31\cdot6} = 1\cdot003.\quad (\text{Sun's diameter} = 1.)$$

Hence it would appear that the eclipse was total; but to find whether it really was so or no, recourse must be had to a more refined method of investigation than that afforded by this approximate solution. (See Remarks, Part I. p. 18).

For the position of the points of contact on the limb of the sun, we have, for direct image,

At Beginning from Vertex 36° towards the Right or West.
Ending —— 145 towards the Left or East.

Example, No. II.

REQUIRED the circumstances of the eclipse of the sun, of July 7th and 8th, 1842, at Woosung, Coast of China. (Latitude, 31° 25′ N.; Longitude, 121° 38′ E.

	h m		° ′
Green. Mean Time of true Conj. in R.A. July 7th	18 54·8	Lat.	31 25 N.
Long. in Time	8 6·5 E.	Red. Tab. I.	9
Local Mean Time T, July 8th	3 1·3	Red. Lat.	31 16 N.

	h m
Mean Time	3 1·3
Equation of Time	4·5
Sun's Hour Angle h	2 56·8 W.

To find the Correction t.

At the time T.
Green. Date, July 7th, 18^h 54^m.

Moon's Rel. Hor. Par.	59′8
— Rel. H.M. in R.A.	36·2
— Decl.	23°

Log. Rel. H.M. in R.A.	1·5587
Log. Sec. Lat.	10·0681
Log. F. Tab. V.	0·1859
	1·8127

Log. K. Tab. VI.	3·6219		3·6219		64·97
Log. 46·17	1·6644	Log. 50·10	1·6998	N. Tab. VI.	18·80
	1·9575		1·9221		46·17
	t nearly $90^m·7$		t $83^m·6$		64·97
				N. Tab. VI.	14·87
					50·10

	h m		h m		h m
h	2 57	h	2 56·8 W.	T	3 1·3
$\frac{1}{2}t$	45	t	1 23·6	t	1 23·6
$h+\frac{1}{2}t$	3 42	Corr. Hour Angle	4 20·4 W.	T′	4 24·9

At the time T′.
Green. Date, July 7th, 20^h 18^m.

Moon's Decl.	22° 51′ 1″ N.
Sun's Decl.	22 32 12 N.
Moon's Rel. Hor. Par.	59′9
— Rel. H.M. in R.A.	36·2
— Rel. H.M. in Decl.	7·5 S.
— Semid.	16·3
Sun's Semid.	15·7
Distance of Centres	32·2
Corr. Hour Angle	4^h 20^m W.

	A.	E.
Tab. VII.	27′3	18′6
Red. by Tab. IX.	28·7	19·5

A	28′·7 N.
E. Corr.	8·2 N.
Moon's Par. in Decl.	20·5 N.

	° ′
Moon's Decl.	22 51·0 N.
Par. in Decl.	20·5 N.
Moon's Corr. Decl.	22 30·5 N.
Sun's Decl.	22 32·2 N.
Diff. Decl.	1·7 S.

Computation for Beginning.

	h m
Corr. Hour Angle	4 20 W.
	30
New Hour Angle	3 50 W.

E = 19′·5 I. Table VII. 51′·2

Par. Corr. in Decl. = $\frac{16'\cdot 3}{4}$ = 4′·1 Par. Corr. in R.A. = $\frac{27'\cdot 8}{4}$ = 6′·9

Par. in R.A. = 43′·0

Moon's Red. Rel. H.M. in R.A....	33′·3	Moon's Rel. H.M. in Decl....	7′·5 S.
Par. Corr. in R.A.	6·9	Par. Corr. in Decl.	4·1 N.
App. Rel. H.M. in R.A.............	26·4	App. Rel. H.M. in Decl.......	11·6 S.

1st Angle of Inclination	24°	From the Traverse Table.
Rel. H.M. in Orbit	28′·9 S.	
Nearest Approach S *n*	1·5	
M *n*	0·7	
2d Angle of Inclination......	87°	
$M_1 n$	32·2	
Par. Angle M........	65°	

Figure to represent the circumstances of the case, same as Case VII. Moon west of meridian, to the southward of the sun, and motion in orbit southerly.

$M_1 n$	32′·2
M *n*	0·7
$M_1 M$	32·9

$\frac{32'\cdot 9}{28\cdot 9} = 1^{h}\cdot 14 = 1^{h}\ 8^{m}\cdot 4$ $\frac{0'\cdot 7}{28\cdot 9} = 0^{h}\cdot 024 = 0^{h}\ 1^{m}4.$

	h m			h m
T′	4 24·9		T′	4 24·9
	1 8·4			0 1·4
Beginning	3 16·5		Greatest Phase	4 23·5

Computation for Ending.

	h m
Corr. Hour Angle	4 20 W.
	30
New Hour Angle	4 50 W.

E 19′·5 I. Table VII. 51′·2

Par. Corr. in Decl. = $\frac{18'\cdot 6}{4}$ = 4′·6 Par. Corr. in R.A. = $\frac{15'\cdot 0}{4}$ = 3′·8

Par. in R.A. = 49′·0

Moon's Red. Rel. H.M. in R.A....	33′·3	Moon's Rel. H.M. in Decl. ...	7′·5 S.
Par. Corr. in R.A....................	3·8	Par. Corr. in Decl................	4·6 N.
App. Rel. H.M. in R.A.............	29·5	App. Rel. H.M. in Decl.......	12·1 S.

1st Angle of Inclination	22°	From the Traverse Table.
Rel. H M. in Orbit	31′8 S.	
Nearest Approach S *n*	1·6	
M *n*	0·6	
2d Angle of Inclination	87°	
$M_2 n$	32′2	
Par. Angle M	67°	

	′
$M_2 n$	32·2
M *n*	0·6
$M_2 M$	31·6

$$\frac{31'\cdot 6}{31\cdot 8} = 0^h\cdot 993 = 0^h\ 59^m\cdot 6$$

	h m
T′	4 24·9
	0 59·6
Ending	5 24·5

Recapitulation.

Eclipse of the Sun, July 8th, 1842, at Woosung.

	h m	
Beginning, July 8th.........	3 16·5	Mean Time at Woosung.
Greatest Phase	4 23·5	
Ending	5 24·5	

At Beginning from Vertex 134° towards Right or West } For direct
Ending —— 48 towards Left or East } image.

Magnitude of the Eclipse $= \frac{32\cdot 2 - 1\cdot 6}{31\cdot 4} = \frac{30\cdot 6}{31\cdot 4} = 0\cdot 974$ (sun's diameter = 1) on the southern limb.

At Woosung, this eclipse was observed* as follows:—

	h m s	
Beginning	3 16 54·7	Mean Time at Woosung.
Ending	5 24 1·0	

Hence the errors of the prediction are $-0^m\cdot 4$ for beginning, and $+0\cdot 5$ for ending.

* By Capt. Sir Everard Home, C.B., H.M.S. North Star.

Example, No. III.

Required the circumstances of the eclipse of the sun of Oct. 30th, 1845, at Hobarton, Van Diemen's Land. (Latitude, 42° 53′ S.; Longitude, 147° 27′ E.)

	h m	
Green. Mean Time of true Conj. in R.A.	12 12·9	
Long. in Time	9 49·8	E.
Local Mean Time T.	22 2·7	
Eq. Time	16·3	
	22 19·0	
Sun's Hour Angle h	1 41·0	East.

	° ′	
Lat.	42 53	S.
Red. Tab. I.	11	
Red. Lat.	42 42	S.

To find the Correction t.

At the time T.
Green. Date, Oct. 30th, 12^h 13^m.

Moon's Rel. Hor. Par.	58′6
— Rel. H.M. in R.A.	32·7
— Declination	15°

Log. Rel. H.M. in R.A.	1·5145
Log. Sec. Lat.	10·1337
Log. F. Tab. V.	0·2180
	1·8662

Log. K. Tab. VI.	3·4081		3·4081
Log. 49·75	1·6968	Log. 51·17	1·7090
	1·7113		1·6991

t nearly = $51^m·4$ t $50^m·0$

	73·49
N. Tab. VI.	23·74
	49·75

	73·49
N. Tab. VI.	22·32
	51·17

	h m
h	1 41
$\frac{1}{2}t$	26
$h+\frac{1}{2}t$	2 7

	h m	
h =	1 41	E.
t	50	
Corr. Hour Angle	2 31	E.

	h m
T =	22 2·7
t	50·0
T′	21 12·7

At the time T′.
Green. Date, Oct. 30th, 11^h 23^m.

Moon's Decl.	14° 45′ 6″	S.
Sun's Decl.	13 59 42	S.
Moon's Rel. Hor. Par.	58′6	
— Rel. H.M. in R.A.	32·7	
— Rel. H.M. in Decl.	7·5	S.
— Semid.	16·1	
Sun's Semid.	16·0	
Distance of Centres	32·3	
Corr. Hour Angle	2^h 31^m	E.

	A.	E.
Tab. VIII.	37′4	10′1
Red. by Tab. IX.	38·4	10·3

	′	
A.	38·4	S.
E. Corr.	8·2	S.
Moon's Par. in Decl.	30·2	S.

	° ′	
Moon's Decl.	14 45·1	S.
Par. in Decl.	30·2	S.
Moon's Corr. Decl.	14 14·9	S.
Sun's Decl.	13 59·7	S.
Diff. Decl.	15·2	S.

Computation for Beginning.

	h m
Corr. Hour Angle	2 31 E.
	30
New Hour Angle	3 1 E.

E = 10′·3 — I. Table VIII. 43′·0

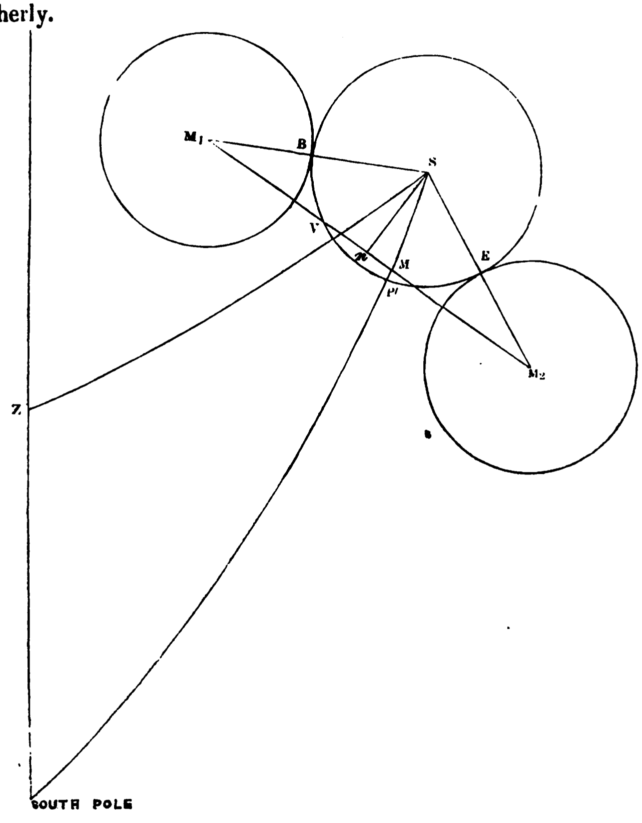
Par. Corr. in Decl. $= \frac{7'\cdot3}{4} = 1'\cdot8$ — Par. Corr. in R.A. $= \frac{30'\cdot4}{4} = 7'\cdot6$

Par. in R.A. = 30′·4

Moon's Red. Rel. H.M. in R.A....	31′·7	Moon's Rel. H.M. in Decl.	7′·5 S.
Par. Corr. in R.A.	7·6	Par. Corr. in Decl..	1·8 N.
App. Rel. Hourly Motion in R.A.	24·1	App. Rel. Hourly Motion in Decl.	9·3 S.

1st Angle of Inclination. ...	22°	From the Traverse Table.
Rel. H.M. in Orbit	26′·0 S.	
Nearest Approach S*n*	14·1	
M*n*............	5·7	
2d Angle of Inclination. ...	64°	
M_1n	29·1	
Par. Angle M	45°	

Figure to represent the circumstances of the case, same as Case VIII. Moon east of meridian, to the southward of the sun, and motion in orbit southerly.



	′
$M_1 n$	29·1
$M n$	5·7
$M_1 M$	34·8

$\frac{34'\cdot 8}{26\cdot 0} = 1^h\cdot 34 = 1^h\ 20^m\cdot 4$ $\quad\quad$ $\frac{5'\cdot 7}{26\cdot 0} = 0^h\cdot 22 = 0^h\ 13^m\cdot 2$

	h m			h m
T′	21 12·7		T′	21 12·7
	1 20·4			13·2
Beginning	19 52·3		Greatest Phase	20 59·5

Computation for Ending.

	h m
Corr. Hour Angle	2 31 E.
	30
New Hour Angle	2 1 E.

E = 10′·3 $\quad\quad$ I. Table VIII. 43′·0

Par. Corr. in Decl. $= \frac{5'\cdot 2}{4} = 1'\cdot 3$ $\quad\quad$ Par. Corr. in R.A. $= \frac{37'\cdot 2}{4} = 9'\cdot 3$

Par. in R.A. = 21′·5

	′		′
Moon's Red. Rel. H.M. in R.A...	31·7	Moon's Rel. H.M. in Decl....	7·5 S.
Par. Corr. in R.A.	9·3	Par. Corr. in Decl.	1·3 N.
App. Rel. H.M. in R.A.	22·4	App. Rel. H.M. in Decl.	8·8 S.

1st Angle of Inclination	21°	From the Traverse Table.
Rel. H.M. in Orbit	24′0 S.	
Nearest Approach $S n$	14·2	
$M n$	5·4	
2d Angle of Inclination	64°	
$M_2 n$	29·1	
Par. Angle M.	35°	

	′
$M_2 n$	29·1
$M n$	5·4
$M_2 M$	23·7

$\frac{23'\cdot 7}{24\cdot 0} = 0^h\cdot 99 = 0^h\ 59^m\cdot 4$ $\quad\quad$ $\frac{5'\cdot 4}{24} = 0^h\cdot 22 = 0^h\ 13^m\cdot 2$

	h m
T′	21 12·7
	0 59·4
Ending	22 12·1

Recapitulation.

Eclipse of the sun, Oct. 30th, 1845, at Hobarton.

	h m	
Beginning, Oct. 30th...	19 52·3	Mean Time at Hobarton.
Greatest Phase	20 59·5	
Ending	22 12·1	

At Beginning from Vertex 41° towards Left } for direct
Ending —— 78 towards Right } image.

Magnitude of the eclipse $= \dfrac{32'{\cdot}3 - 14'{\cdot}2}{32{\cdot}0} = \dfrac{18'{\cdot}1}{32{\cdot}0} = 0{\cdot}565$ on southern limb (sun's diameter = 1),

At Hobarton, this eclipse was observed* as follows :—

	h	m	s	
Beginning	19	53	54·1	Mean Time at Hobarton.
Ending	22	11	47·1	

Hence the errors of the prediction are $-1^{m}{\cdot}6$ for beginning, and $+0^{m}{\cdot}3$ for ending.

Example, No. IV.

Required the circumstances of the eclipse of the sun of Oct. 8th, 1847, at Dublin. (Lat. 53° 23′ N.; Long. $0^{h}\ 25^{m}\ 22^{s}$ W.)

	h m	
Green. Mean Time of true Conj. in R.A.	20 38·7	
Long. in Time	0 25·4	W.
Local Mean Time T.	20 13·3	
Eq. Time	12·5	
	20 25·8	
Sun's Hour Angle *h*	3 34	East.

	° ′	
Lat.	53 23	N.
Red. Tab. I.	11	
Red. Lat.	53 12	N.

To find the Correction t.

At the Time T.
Green. Date, Oct. 8th, $20^{h}\ 38^{m}$.

Moon's Rel. Hor. Par.	53′8
— Rel. H.M. in R.A.	26·1
— Decl.	6°

Log. Rel. H.M. in R.A. ...	1·4166
Log. Sec. Lat.	10·2226
Log. F. Tab. VI.	0·2660
	1·9052

Log. K. Tab. VI....	3·6833	....	3·6833
Log. 64·78	1·8114	Log. 68·37 ...	1·8349
	1·8719		1·8484

	80·39
N. Tab. VI. ...	15·61
	64·78
	80·39
N. Tab. VI. ...	12·02
	68·37

t nearly $= 74^{m}{\cdot}5$ $\qquad$ $t = 70^{m}{\cdot}5$

	h m
h =	3 34
$\frac{1}{2}t$	0 37
$h + \frac{1}{2}t$	4 11

	h m	
h	3 34	E.
t	1 10·5	
Corr. Hour Angle...	4 44·5	E.

	h m
T =	20 13·3
t =	1 10·5
T′ =	19 2·8

* By Lieut. J. H. Kay, R.N. Director of the Magnetic Observatory.

At the time T′.

Green. Date, Oct. 8th, $19^h\ 28^m$.	
Moon's Decl.	5° 21′ 53″ S.
Sun's Decl.	6 3 32 S.
Moon's Rel. Hor. Par.	53′8
— Rel. H.M. in R.A.	26·1
— Rel. H.M. in Decl.	8·0 S.
— Semid.	14·7
Sun's Semid.	16·0
Distance of Centres	30·9
Corr. Hour Angle	$4^h\ 44^m$ E.

	A.	E.
Tab. VIII.	45′3	3′6
Red. by Tab. IX.	42·8	3·4

A	42′8 N.
E. Corr.	1·0 S.
Moon's Par. in Decl.	43·8 N.

Moon's Decl.	5° 21′·9 S.
Par. in Decl.	43·8 N.
Moon's Corr. Decl	6 5·7 S.
Sun's Decl.	6 3·5 S.
Diff. Decl.	2·2 S.

Computation for Beginning.

	h m
Corr. Hour Angle	4 44 E.
	30
New Hour Angle	5 14 E.

E = 3′·4 I. Table VIII. 32′·1

$$\text{Par. Corr. in Decl.} = \frac{3'\cdot3}{4} = 0'\cdot8 \qquad \text{Par. Corr. in R.A.} = \frac{6'\cdot1}{4} = 1'\cdot5$$

Par. in R.A. = 31′·5

Moon's Red. Rel. H.M. in R.A.	26′0
Par. Corr. in R.A.	1·5
App. Rel. H.M. in R.A.	24·5

Moon's Rel. H.M. in Decl.	8′0 S.
Par. Corr. in Decl.	0·8 N.
App. Rel. H.M. in Decl.	8·8 S.

1st Angle of Inclination	20°	From the Traverse Table.
Rel. H.M. in Orbit	26′1 S.	
Nearest approach S *n*	2·1	
M *n*	0·7	
2d Angle of Inclination	86°	
$M_1 n$	30·8	
Par. Angle M	36°	

Figure to represent the circumstances of the case, same as Case VIII. Moon east of meridian, to the southward of the sun, and motion in orbit southerly.

$M_1 n$	30′8
M *n*	0·7
$M_1 M$	31·5

$$\frac{31'\cdot5}{26\cdot1} = 1^h\cdot21 = 1^h\ 12^m\cdot6 \qquad \frac{0'\cdot7}{26\cdot1} = 0^h\cdot03 = 0^h\ 1^m\cdot8$$

	h m
T′	19 2·8
	1 12·6
Begins	17 50·2

	h m
T′	19 2·8
	1·8
Greatest Phase	19 1·0

Computation for Ending.

	h m
Corr. Hour Angle	4 44 E.
	30
New Hour Angle	4 14 E.

E = 3′·4   I. Table VIII. 32′·1

Par. Corr. in Decl. = $\frac{3'\cdot1}{4}$ = 0′·8   Par. Corr. in R.A. = $\frac{14'\cdot1}{4}$ = 3′·5

Par. in R.A. = 28′·9

Moon's Red. Rel. H.M. in R.A.	26′·0	Moon's Rel. H.M. in Decl.	8′·0 S.
Par. Corr. in R.A.	3·5	Par. Corr. in Decl.............	0·8 N.
App. Rel. H.M. in R.A..........	22·5	App. Rel. H.M. in Decl.....	8·8 S.

1st Angle of Inclination......	21°	From the Traverse Table.
Rel. H.M. in Orbit	24′·1 S.	
Nearest Approach Sn	2·1	
Mn	0·7	
2d Angle of Inclination	86°	
M_2n	30·8	
Par. Angle M	33°	

M_2n	30′·8
Mn	0·7
M_2M	30·1

$\frac{30'\cdot1}{24\cdot1} = 1^h\cdot25 = 1^h\ 15^m$

	h m
T′	19 2·8
	1 15
Ends	20 17·8

Recapitulation.

Eclipse of the sun on Oct. 8th, 1847, at Dublin.

	h m			m
Begins, Oct. 8th	17 50·2	Mean Time at Dublin	Errors on "Nautical Almanac"	−0·6
Greatest Phase	19 1·0			−0·4
Ends	20 17·8			−1·1

(See "Nautical Almanac," 1847, p. 549.)

At Beginning, Angle from Vertex 38° towards Right or West.
Ending ——— ——— 148 towards Left or East.

Magnitude = $\frac{30\cdot9 - 2\cdot1}{32} = \frac{28\cdot8}{32}$ = 0·900 on southern limb (sun's diameter = 1).

Explanation of the Diagrams illustrative of the various cases of Occultations.

P Z represents a portion of the celestial meridian.

P the pole of the heavens.

Z the zenith.

P M an arc of a circle of declination, and Z M an arc of a circle of altitude passing through the moon.

M and S the relative positions of the moon's centre and the star, as seen by the spectator at the earth's surface, and therefore as affected by parallax, at the time T′, the moment of apparent conjunction (☌) in right ascension.

The arrowed line passing through M, the apparent orbit of the moon during the period of the occultation.

The line B E the chord of the moon, described by the star, in an opposite direction to that of the moon's motion, such as it would appear to the observer if the moon were transparent.

B the point where the star enters the moon.

E the point where it emerges.

n the point of nearest approach.

M S the apparent difference of declination at the time T′.

M *n* the nearest approach of the moon's centre to the star.

M B and M E radii of the moon or her semidiameter.

P′ the north pole, and V the vertex of the moon.

The angle *n* M S the first angle of inclination (or ι).

The angle B M *n* or E M *n* the second angle of inclination (or ω).

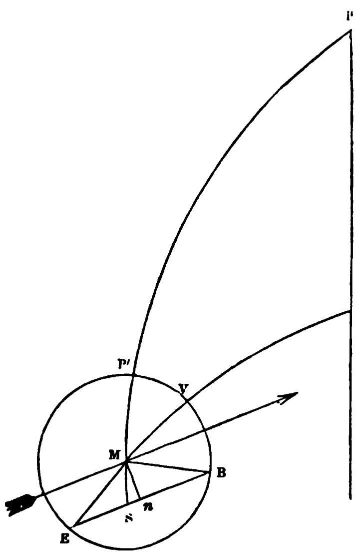
The angle P M Z the parallactic angle M.

These figures are all drawn on the supposition of the north pole being the elevated pole. Should the computations be made for places in south latitude, by drawing P Z indefinitely downwards, and assuming proper points in it to represent the zenith and pole, the necessary figure will be obtained.*

* See Examples of Occultations, Part I. No. II. and Part II. Nos. I. III. and VIII.

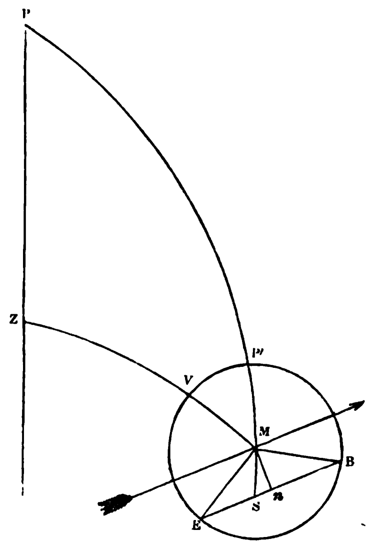
Diagrams illustrative of the various cases of Occultations.

Case I.



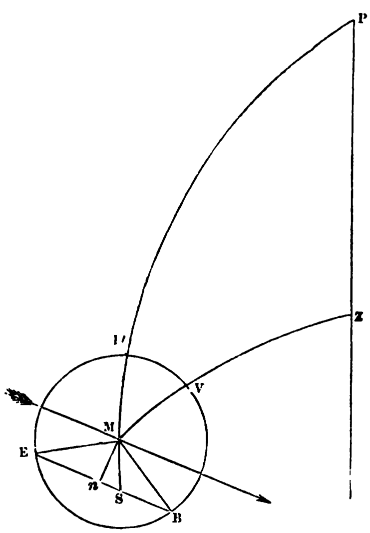
Moon west of meridian, centre to the northward of the star, and motion in orbit northerly.

Case II.



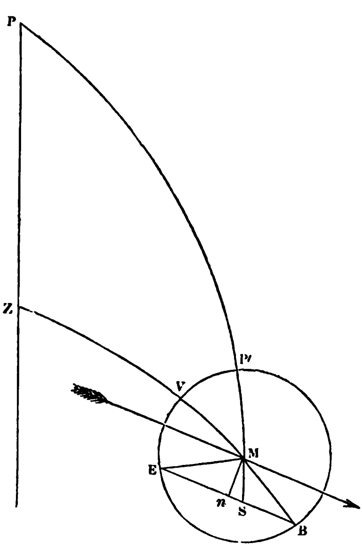
Moon east of meridian, centre to the northward of the star, and motion in orbit northerly.

Case III.



Moon west of meridian, centre to the northward of the star, and motion in orbit southerly.

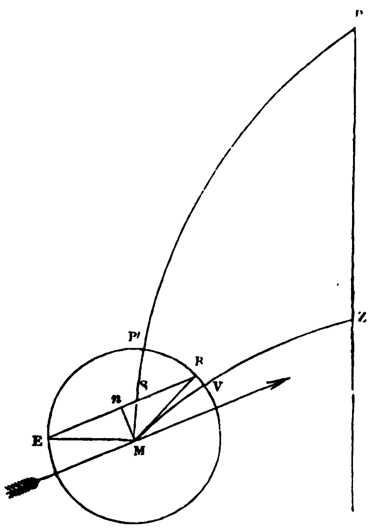
Case IV.



Moon east of meridian, centre to the northward of the star, and motion in orbit southerly.

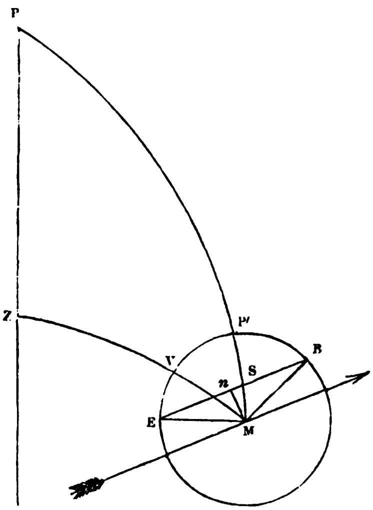
Diagrams illustrative of the various cases of Occultations.

Case V.



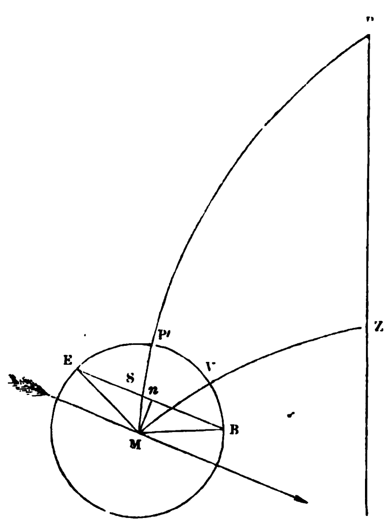
Moon west of meridian, centre to the southward of the star, and motion in orbit northerly.

Case VI.



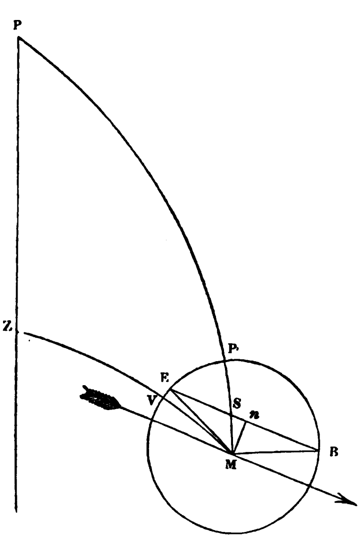
Moon east of meridian, centre to the southward of the star, and motion in orbit northerly.

Case VII.



Moon west of meridian, centre to the southward of the star, and motion in orbit southerly.

Case VIII.



Moon east of meridian, centre to the southward of the star, and motion in orbit southerly.

Explanation of the Diagrams illustrative of the various cases of Solar Eclipses.

P Z represents a portion of the celestial meridian.

P the pole of the heavens.

Z the zenith.

P S an arc of a circle of declination, and Z S an arc of a circle of altitude passing through the sun.

M_1 the position of the moon at the beginning of the eclipse.

M_2 her position at the end.

M the position of the moon at the moment of apparent conjunction (☌) in right ascension, or at the time T′.

M_1 M M_2 her apparent relative orbit, as seen by the spectator at the earth's surface during the occurrence of the eclipse (the sun being supposed to be relatively stationary).

B the point of contact at beginning.

E the point of contact at ending.

n the point of nearest approach.

S M the apparent difference of declination at the time T′.

S *n* the nearest approach of the centre of the moon to that of the sun.

S M_1 and S M_2 the sum of the semidiameters of the sun and moon, or the distance of the centres.

P′ the north pole, and V the vertex of the sun.

The angle M S *n* the first angle of inclination (or ι).

The angle M_1 S *n* or M_2 S *n* the second angle of inclination (or ω).

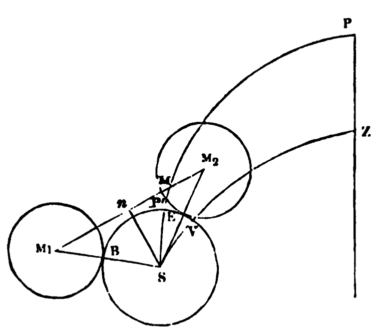
The angle P S Z the parallactic angle M.

These figures are all drawn on the supposition of the north pole being the elevated pole. Should the computation be made for a place in south latitude, by drawing P Z indefinitely downwards and assuming proper points in it, to represent the zenith and pole, the necessary figure will be obtained.*

* See Examples of Solar Eclipses, No. III.

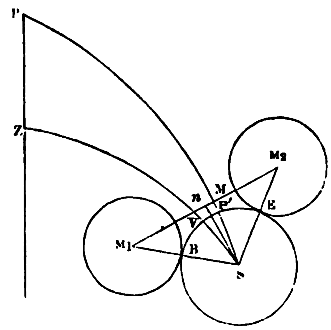
Diagrams illustrative of the various cases of Solar Eclipses.

Case I.



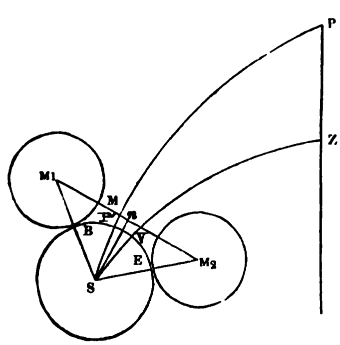
Moon west of meridian, to the northward of the sun, and motion in orbit northerly.

Case II.



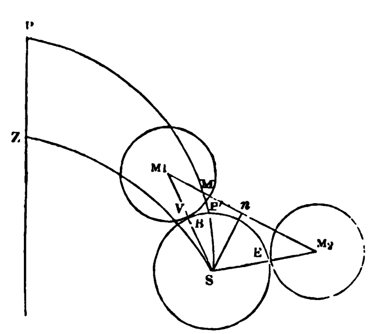
Moon east of meridian, to the northward of the sun, and motion in orbit northerly.

Case III.



Moon west of meridian, to the northward of the sun, and motion in orbit southerly.

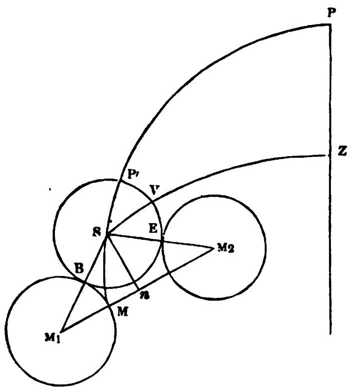
Case IV.



Moon east of meridian, to the northward of the sun, and motion in orbit southerly.

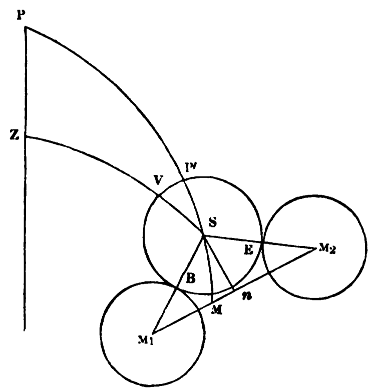
Diagrams illustrative of the various cases of Solar Eclipses.

Case V.



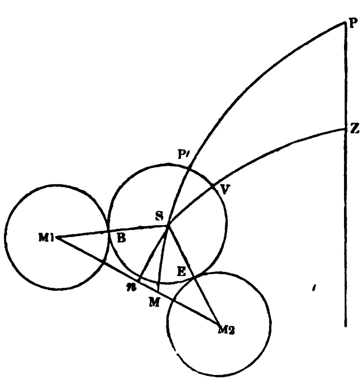
Moon west of meridian, to the southward of the sun, and motion in orbit northerly.

Case VI.



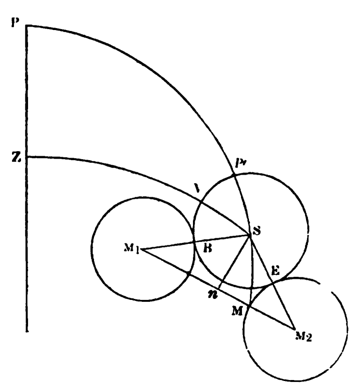
Moon east of meridian, to the southward of the sun, and motion in orbit northerly.

Case VII.



Moon west of meridian, to the southward of the sun, and motion in orbit southerly.

Case VIII.



Moon east of meridian, to the southward of the sun, and motion in orbit southerly.

Supplementary Observations.

In conclusion, it merely remains for us to point out that, in the preliminary determination of the time T′ of apparent conjunction in right ascension, the correction t might be obtained without the intervention of Tables V. and VI. solely by means of the quantity I, combined with the use of the Traverse Table.

For referring to equation (15), (Part I. p. 11),

$$t = \frac{\Delta \alpha}{\alpha_1 - \Delta \alpha_1},$$

the value of which expression will not be changed by reducing all the terms which it involves to the parallel of declination,

$$\therefore \quad t = \frac{\Delta \alpha \text{ red.}}{\alpha_1 \text{ red.} - \Delta \alpha_1 \text{ red.}},$$

or

$$t = \frac{\text{I} \sin h}{\alpha_1 \cos \text{D} - \frac{\text{I} \cos h}{4}},$$

(See equations 22 and 20, Part I. p. 14);

in solving which equation, it will be advisable first to determine the value of t approximately, using that value of $\Delta \alpha_1$ red. which corresponds to the hour angle h, and then to repeat the operation with that value of $\Delta \alpha_1$ red. which corresponds to the hour angle $h + \frac{t}{2}$. (See Part I. p. 12.)

From these considerations we have the following practical rule:—

Take out the quantity I from Table VII. or VIII. corresponding to the moon's parallax.

For the time T find h, the common hour angle of the moon and star, or of the sun and moon, as the case may be, and also take from the ephemeris the hourly motion in right ascension, or relative hourly motion in the case of a planetary occultation or solar eclipse, to the nearest tenth of a minute of arc, and the moon's declination to the nearest degree.

Enter the Traverse Table with the hour angle *h* as a course, and I in the distance column, the corresponding difference of latitude, divided by 4, will be the parallactic correction in right ascension, and the departure the parallax in right ascension.

With the moon's declination as a course and her hourly motion in right ascension in the distance column, enter the Traverse Table; the corresponding difference of latitude will be the moon's reduced hourly motion in right ascension.

Under the moon's reduced hourly motion in right ascension place the parallactic correction; if the hour angle is less than 6^h, take their difference; if greater, their sum: the result will be the apparent hourly motion in right ascension.

Divide the parallax in right ascension by the apparent hourly motion in right ascension, the quotient will be the approximate value of the correction *t*, in units of an hour, which reduce to minutes by multiplying it by 60.

Increase the hour angle *h* by half the correction *t* to the nearest minute.

With the hour angle so increased as a course in the Traverse Table and I in the distance column, the corresponding difference of latitude, divided by 4, will be a new value of the parallactic correction.

Apply this parallactic correction to the reduced hourly motion in right ascension, as before, and divide the parallax in right ascension by the new value of the apparent hourly motion in right ascension so obtained.

The quotient will be the correction *t*, in units of an hour, which reduce to minutes by multiplying it by 60, pointing off as many places in the product as there are in the multiplicand.

Under T place the correction *t*: if the hour angle *h* is *west*, add; if *east*, subtract: the result will be the time T′ of apparent conjunction in right ascension.

Increase the hour angle *h* by the correction *t*; the result will be the corrected hour angle.

Example, No. I.

TAKING the case of the occultation of *υ Leonis* at Greenwich, on March 2d, 1847. (Occultations, Example II. p. 42.)

At the time T, March 2d, $14^h\ 47^m$ Greenwich Mean Time.

Moon's Hor. Par.	=	53′9
— H.M. in R.A.	=	28·0
— Decl.		1°
Hour Angle *h*		$1^h\ 59^m$ W.

whence I. Tab. VIII. = 33′·6

Par. Corr. in R.A. $= \frac{29'\cdot 1}{4} = 7'\cdot 3$ Par. in R.A. = 16′·8

Moon's Red. H.M. in R.A.	28′·0
Par. Corr. in R.A.	7·3
App. H.M. in R.A.	20·7

t nearly $= \frac{16'\cdot 8}{20\cdot 7} = 0^h\cdot 81 = 0^h\ 48^m\cdot 6$

	h m
h	1 59
½ *t*	24
h + ½ *t*	2 23

Par. Corr. in R.A. $= \frac{27'\cdot 2}{4} = 6'\cdot 8$

Moon's H.M. in R.A.	28′·0
Par. Corr. in R.A.	6·8
App. H.M. in R.A. ...	21·2

$t = \frac{16'\cdot 8}{21\cdot 2} = 0^h\cdot 79 = 0^h\ 47^m\cdot 4$

		h m			h m
	h	1 59 W.		T	14 47·4
	t	47·4		*t*	47·4
Corr. Hour Angle		2 46·4 W.		T′	15 34·8

which results agree very nearly with those obtained by the former method.

Example, No. II.

IN the case of the occultation of the planet *Saturn* at the Cape of Good Hope, Dec. 22d, 1849. (Occultations, Example VIII. p. 55.)

At the time T, Dec. 22d, $9^h\ 27^m$ Cape Mean Time.

Moon's Hor. Par.	=	56′5
— H.M. in R.A.......	=	30·4
— Decl.	=	2°
— Hour Angle *h*	=	$3^h\ 23^m$ W.

whence I. Table VIII = 46′·9

Par. Corr. in R.A. $= \frac{29'\cdot5}{4} = 7'\cdot4$ Par. in R.A. $= 36'\cdot5$

Moon's Red. H.M. in R.A.	30′·4
Par. Corr. in R.A.	7·4
App. H.M. in R.A.	23·0

t nearly $= \frac{36'\cdot5}{23\cdot0} = 1^{h}\cdot6 = 1^{h}\ 36^{m}\cdot0$

	h m
h	3 23
$\frac{1}{2}t$	48
$h+\frac{1}{2}t$	4 11

Par. Corr. in R.A. $= \frac{21'\cdot2}{4} = 5'\cdot3$

Moon's H.M. in R.A.	30′·4
Par. Corr. in R.A.	5·3
App. H.M. in R.A.	25·1

$t = \frac{36'\cdot5}{25\cdot1} = 1^{h}\cdot45 = 1^{h}\ 27^{m}\cdot0$

		h m			h m
	h	3 23 W.		T	9 27·0
	t	1 27		t	1 27
Corr. Hour Angle		4 50 W.		T′	10 54

which results agree very nearly with the previous determination.

Example, No. III.

ECLIPSE of the sun at Marseilles, July 7th, 1842. (Eclipses, Example I. p. 60.)

At the time T, July 7th, $19^{h}\ 16^{m}\cdot3$ Marseilles Mean Time.

Moon's Hor. Par.	59′8
Rel. H.M. in R.A.	36·2
Decl.	23°
Hour Angle h	$4^{h}\ 48^{m}$ E.

whence I. Table VII. $= 43'\cdot6$

Par. Corr. in R.A. $= \frac{13'\cdot5}{4} = 3'\cdot4$ Par. in R.A. $= 41'\cdot4$

Moon's Red. Rel. H.M. in R.A....	33′·3
Par. Corr. in R.A.	3·4
App. Rel. H.M. in R.A............	29·9

t nearly $= \frac{41'\cdot4}{29\cdot9} = 1^{h}\cdot4 = 1^{h}\ 24^{m}$

	h m
h	4 48
$\frac{1}{2}t$	42
$h+\frac{1}{2}t$	5 30

Par. Corr. in R.A. $= \frac{5'\cdot3}{4} = 1'\cdot4$

Moon's Red. Rel. HM. in R.A.	33′·3
Par. Corr. in R.A.	1·4
App. Rel. H.M. in R.A.	31·9

$t = \frac{41'.4}{31.9} = 1^{h}.3 = 1^{h}\ 18^{m}.0$

	h m		h m
h =	4 48 E.	T =	19 16·3
t	1 18	t	1 18
Corr. Hour Angle	6 6 E.	T′	17 58·3

which results agree very nearly with those obtained by the other method.

This method of solution has the advantage of entirely dispensing with the use of logarithms, and of reducing all the parts of the computations to processes of the same form.

On the other hand, its results are not likely to be quite so accurate, and an inexperienced computer might possibly be led into error by making a confusion between the various values of the hour angle, which are used at different stages of the process; and perhaps, therefore, on this account, the former method by logarithms, involving the aid of Tables V. and VI. may with greater safety be recommended to computers generally.

EXPLANATION OF THE TABLES.

TABLES I. AND II.

TABLE I. *Reduction of the Latitude.*

THIS table contains the correction to be applied to the geographical latitude, in order to obtain the geocentric latitude, or what the latitude would be, were the earth a perfect sphere.

Table II. contains the logarithm of the earth's radius for every degree of latitude; the equatorial radius being assumed equal to unity.

These two tables have been taken from Mr. Woolhouse's "Treatise on Eclipses" (Appendix, "Nautical Almanac," 1836, pp. 57 and 58); Table II. being extended to six places of decimals.

TABLE I A.

Acceleration of Sidereal on Mean Time.

THE use of this table is too well known to require a lengthened explanation here; in its present form (the arguments being given to the nearest hour and minute of mean time corresponding to the nearest minute and tenth of acceleration) it will probably be found more convenient for the purposes required, than in the form in which it is usually expressed.

TABLE III.

Reduction of the Moon's Meridian Passage.

THIS table, which is to be found in all treatises on navigation, has been taken as it stands from Mr. Simms' "Treatise on the Use of Instruments."

The table is to be entered with the daily change of the moon's meridian passage at the top, and the longitude at the side column.

The daily change in west longitude is the difference between the times of the moon's transit on the given and following days; in east longitude, it is the difference between the times of transit on the given and the preceding day.

In west longitude, *add* the correction to the time of meridian passage on the given day; in east longitude, *subtract* it.

TABLE IV.

SEMIDIURNAL ARCS,

To find the Time of the Rising and Setting of the Heavenly Bodies.

THIS table is to be entered with the declination at the top, and the latitude at the side column. The corresponding time will be the semiduration *above* the horizon when the latitude and declination have like names; and the semiduration *below* the horizon when their names are unlike.

When the latitude and declination have like names, subtract the time found in the table from the time of meridian passage of the body for the time of rising, and add it for the time of setting.

When the latitude and declination have unlike names, subtract the time found in the table from 12^h, and proceed as before.

This table has been taken from Norie's "Navigation."

TABLES V. AND VI.

Logarithms F *and* K, *and Natural Number* N.

THESE tables are useful in determining the correction t, to be applied to the time of true conjunction in right ascension between the moon and a star, as seen from the earth's centre, or T, in order to give the time of apparent conjunction in right ascension, as seen from the earth's surface, or T′, by the formula

$$T' = T + t$$

where $$t = \frac{6000 \sin h}{a_1 \sec. l . \left(\frac{100 \cos D}{P}\right) - [1\cdot419157] \cos h}$$

(See Part I. p. 11).

Table V. contains $\log F = \frac{100 \cos D}{P}$; Table VI. contains $\log K = 6000 \sin h$; and the number $N = [1\cdot419157] \cos h$; h, D, and P respectively representing the moon's hour angle, declination, and horizontal parallax. When the hour angle exceeds 6^h, enter Table VI. with its supplement, or what it wants of 12^h.

Tables VII. and VIII.

The formula expressing the moon's parallax in declination at any moment is

$$\Delta D = \varrho P \sin l \cos D' - \varrho P \cos l \sin D' \cos h$$

(See Part I. pp. 7 and 13).

where ϱ represents the earth's radius in terms of the equatorial radius as unity; P the moon's equatorial horizontal parallax; l the geocentric latitude of the spectator; D′ the moon's apparent declination; and h her hour angle.

Assuming P at a mean value of 57′, and making

$$\varrho P \sin l \cos D' = A,$$

$$\varrho P \cos l \sin D' = E,$$

the formula becomes

$$\Delta D = A - E . \cos h.$$

In which expression A will always have the same name as the latitude. And when the hour angle is less than 6^h, E cos h will have the same name as the declination, and a contrary name to the declination when the hour angle is greater than 6^h.

The quantity E is also useful in determining the parallactic correction in declination.

Since $$\Delta D_1 = \frac{E . \sin h}{4}$$

(See Part I. p. 14).

Table VII. contains the values of A and E for every degree of latitude from the equator up to 70°, and for every degree in the range of the moon's declination; and Table VIII. contains the same quantities for several special places, viz. for all the principal British and for a few of the principal foreign observatories. For all the places recommended by Mr. Raper, as stations for secondary meridians,* and also for a few maritime stations, principally selected for the convenience of naval officers.

When the moon's horizontal parallax is other than 57′, the quantities A and E are to be reduced to their proper values by multiplying them by the factor p, contained in the Auxiliary Table, where $p = \frac{N}{57}$, and where N = successively 53′, 53′·5, 54′, &c., or, by inspection, from Table IX. (which will be explained further on).

At the foot of Tables VII. and VIII. will be found the quantity $I = \varrho P . \cos l$, useful in determining the moon's parallax in right ascension, and the parallactic correction in right ascension.

Since
$$\Delta \alpha = I . \sin h,$$
$$\Delta \alpha_1 = \frac{I . \cos h}{4},$$

(See Part I. p. 14).

These quantities involve in their construction all the corrections, both in the latitude and parallax, which are due to the earth's spheroidity; but it may be proper to observe, with reference to Table VII. that the argument of the table is to be the geographical latitude, and not the reduced or geocentric latitude.

Also in strictness, since the moon's declination, which enters into the formula, is her apparent declination; that is, that very quantity, which it is the object of the table to enable us to determine, it will be proper for the computer, when interpolating between the terms, to make an allowance in using the argument, moon's apparent declination, for the change which the parallax will produce on her true declination.

And since, in general, the effects of parallax in the case of

* See Raper's "Practice of Navigation," Explanation of Table 8, Maritime Positions.

an occultation, at the moment of apparent conjunction, will be to approximate the position of the moon to that of the star, the star's declination may, in practice, safely be substituted for that of the moon as the argument of the table.

Since the difference between the consecutive values of the quantity I for any given latitude, produced by a change of 1′ in the parallax, is a constant quantity, that difference has been inserted in a column in the table; but since the variation in the values of A and E, produced by an increase of latitude or declination, follows a law which is subject to a rapid and, at the same time, irregular alteration, it has not been considered expedient to insert any column of differences for the purpose of interpolation between the terms; while, at the same time, it is hoped that the limits within which the tables have been constructed will be found sufficiently convenient, and that, therefore, computers will not experience any difficulty on that account.

The quantities A, E, and I are expressed in minutes and decimals of a minute of arc, and are given in the tables to two places of decimals; but the only object in doing so is for the greater facility of interpolation, as it will be quite sufficient in all cases to take them out to the nearest tenth.

The latitudes which have been adopted in the construction of Table VIII. have been taken for the astronomical observatories from the Table of Positions given annually in the "Nautical Almanac," and for the remaining places from Mr. Raper's Table of Maritime Positions (see Raper's "Navigation," Table 8).

The quantities given in Table VIII. will serve equally for the computation of occultations at all places lying in the same, or nearly the same, parallel of latitude.

Annexed is a list of places whose latitudes do not differ more than 5′ from those of the places for which special tables are given in Table VIII.; and for which places, therefore, those tables will equally serve.

Trincomalee,	Sierra Leone,
Callao,	Curaçoa, Granada,
Madras,	Bahia, Barbadoes,
Martinique,	Manilla,
St. Helena,	Guadaloupe,
Tahiti,	Belize,

Havannah,	Canton,
Paramatta,	Beyrout,
Palermo,	Messina,
Halifax,	Modena,
Milan,	Padua, Verona,
Portsmouth,	Brussels,
Greenwich,	Kensington, Kew, Blackheath, Slough, Gottingen, Falkland Islands (Port Louis),
Oxford,	Cork,
Cambridge,	Waterford,
Berlin,	Limerick,
Dublin,	Liverpool,
Altona,	Ormskirk,
Durham,	Königsberg, Wilna,
Edinburgh,	Glasgow,
St. Petersburgh,	Cronstadt, Christiana.

When persons who are desirous of making observations of occultations happen to be permanently stationed at any particular place, it may frequently be convenient for them to compute a special table of the values of A, E, and I for their own use.

The mode of proceeding will be as follows:—

Reduce the latitude of the place by the reduction in Table I.

To find the Constant for A.

To the log. 1·755875 (the log. of 57′) add log. ϱ from Table II. corresponding to the latitude, and the log. sine of the reduced latitude, the resulting logarithm, rejecting the tens in the index, will be the constant for A.

To find the Constant for E.

To the logarithm 1·755875 add log. ϱ and the log. cosine of the reduced latitude; the sum, rejecting the tens in the index, will be the constant for E.

Then to the constant for A add successively log. cosine 1°, 2°, 3°, 4°, &c.

And to the constant for E add successively log. sine 1°, 2°, 3°, 4°, &c.

The natural numbers of the resulting logarithms will be the values of the consecutive terms in the series of A and E.

To find the Quantity I.

To the constant for E add successively the logarithm of $p = \frac{N}{57}$ where N = successively 53′, 54′, 55′, &c.

The result will be the logarithms of the consecutive terms in the series of I.

The logs. of $p = \frac{N}{57}$ are as follows:—

Moon's Hor. Par.	Log. p.	Moon's Hor. Par.	Log. p.
53′·0	9·968401	57′·5	0·003793
53·5	9·972479	58·0	0·007553
54·0	9·976519	58·5	0·011281
54·5	9·980522	59·0	0·014977
55·0	9·984488	59·5	0·018642
55·5	9·988418	60·0	0·022276
56·0	9·992313	60·5	0·025880
56·5	9·996173	61·0	0·029455
57·0	0·000000		

Example.

Suppose it were required to compute a special table for Tahlee, Port Stephens, New South Wales, whose latitude is 32° 40′ 18″ S.

	° ′ ″
Latitude	32 40 18 S.
Red. Tab. I..	10 15
Red. Lat.	32 30 3 S.

	1·755875	....	1·755875
Log. ϱ, Tab. II.	9·999591	....	9·999591
Log. Sine Red. Lat....	9·730226	Log. cos Red. Lat.	9·926025
Constant for A.........	1·485692	Constant for E	1·681491

To find A.

Decl.	0°	1°	2°	3°
Constant	1·485692	1·485692	1·485692	1·485692
Cos. Decl.	......	9·999934	9·999735	9·999404
		1·485626	1·485427	1·485096
A =	30·60	30·59	30·58	30·56 &c.

To find E.

Decl.	0°	1°	2°	3°
Constant	1·681491	1·681491	1·681491	1·681491
Sin. Decl.	......	8·241855	8·542819	8·718800
		9·923346	0·224310	0·400291
E =	0·00	0·8382	1·676	2·514 &c.

To find I.

	53′	54′	55′	56′
Constant for E	1·681491	1·681491	1·681491	1·681491
Log. p	9·968401	9·976519	9·984488	9·992313
	1·649892	1·658010	1·665979	1·673804
I =	44·66	45·50	46·34	47·18 &c.

Hence we have the following table:—

Moon's Appt. Decl.	Tablez. 32° 30′·3 S.	
	A.	E.
0°	30·60	0·00
1	30·59	0·84
2	30·58	1·68
3	30·56	2·51
	&c.	
Moon's Hor. Par.	I.	Diff.
53′	44·66	0·84
54	45·50	...
55	46·34	...
56	47·18	...
	&c.	

Table IX.

This table contains the values of A and E for every minute of the moon's actual parallax, corresponding to the tabular values of A and E, or their values for 57′, as given in Tables VII. and VIII.; and these values are obtained by multiplying the tabular values of A and E by the factor $p = \frac{N}{57}$ (see Part I. p. 13).

The table is to be entered with the moon's horizontal parallax at the top, and the tabular values of A or E at the side columns. The corresponding quantity will be the value of A or E required.

Table I.

Reduction of the Latitude,

Always Subtractive.

Latitude.		Reduction.	Latitude.		Reduction.
°	°	′ ″	°	°	′ ″
0	90	0 0	23	67	8 7
1	89	0 24	24	66	8 23
2	88	0 47	25	65	8 39
3	87	1 11	26	64	8 54
4	86	1 34	27	63	9 8
5	85	1 58	28	62	9 22
6	84	2 21	29	61	9 34
7	83	2 44	30	60	9 47
8	82	3 7	31	59	9 58
9	81	3 29	32	58	10 9
10	80	3 52	33	57	10 19
11	79	4 14	34	56	10 28
12	78	4 36	35	55	10 37
13	77	4 57	36	54	10 44
14	76	5 18	37	53	10 51
15	75	5 39	38	52	10 57
16	74	5 59	39	51	11 3
17	73	6 19	40	50	11 7
18	72	6 38	41	49	11 11
19	71	6 57	42	48	11 14
20	70	7 15	43	47	11 16
21	69	7 33	44	46	11 17
22	68	7 51	45	45	11 17

Table I A.

Acceleration of Sidereal on Mean Time.

Mean Time.	Acceleration.	Mean Time.	Acceleration.	Mean Time.	Acceleration.	Mean Time.	Acceleration.
h m	m	h m	m	h m	m	h m	m
0 37	0·1	6 42	1·1	12 47	2·1	18 52	3·1
1 13	0·2	7 18	1·2	13 24	2·2	19 29	3·2
1 50	0·3	7 55	1·3	14 00	2·3	20 5	3·3
2 26	0·4	8 31	1·4	14 37	2·4	20 42	3·4
3 3	0·5	9 8	1·5	15 13	2·5	21 18	3·5
3 39	0·6	9 44	1·6	15 50	2·6	21 55	3·6
4 16	0·7	10 21	1·7	16 26	2·7	22 31	3·7
4 52	0·8	10 57	1·8	17 3	2·8	23 8	3·8
5 29	0·9	11 34	1·9	17 39	2·9	23 44	3·9
6 5	1·0	12 10	2·0	18 16	3·0		

TABLE II.

LOG. RADIUS OF THE EARTH.

Lat.	Log. ϱ.	Lat.	Log. ϱ.	Lat.	Log. ϱ.
0°	0·000000	30°	9·999646	60°	9·998933
1	0·000000	31	9·999624	61	9·998912
2	9·999998	32	9·999603	62	9·998891
3	9·999996	33	9·999579	63	9·998870
4	9·999993	34	9·999557	64	9·998851
5	9·999989	35	9·999534	65	9·998830
6	9·999984	36	9·999510	66	9·998811
7	9·999979	37	9·999487	67	9·998792
8	9·999973	38	9·999462	68	9·998776
9	9·999966	39	9·999439	69	9·998759
10	9·999957	40	9·999414	70	9·998742
11	9·999948	41	9·999389	71	9·998726
12	9·999939	42	9·999365	72	9·998711
13	9·999928	43	9·999340	73	9·998697
14	9·999917	44	9·999315	74	9·998683
15	9·999905	45	9·999290	75	9·998670
16	9·999892	46	9·999265	76	9·998658
17	9·999879	47	9·999240	77	9·998647
18	9·999865	48	9·999216	78	9·998636
19	9·999850	49	9·999191	79	9·998627
20	9·999834	50	9·999166	80	9·998617
21	9·999818	51	9·999142	81	9·998609
22	9·999801	52	9·999118	82	9·998601
23	9·999784	53	9·999094	83	9·998595
24	9·999766	54	9·999069	84	9·998589
25	9·999747	55	9·999046	85	9·998585
26	9·999729	56	9·999023	86	9·998581
27	9·999708	57	9·999000	87	9·998578
28	9·999688	58	9·998977	88	9·998576
29	9·999667	59	9·998955	89	9·998574
				90	9·998573

Table III.

Correction of the Moon's Meridian Passage.

Longitude West, *add*; Longitude East, *subtract*.

Long. in Time.	Daily Change of Moon's Meridian Passage.														Long. in Arc.
	40m	42m	44m	46m	48m	50m	52m	54m	56m	58m	60m	62m	64m	66m	
h m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	°
0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5
40	1	1	1	1	1	1	1	1	1	2	2	2	2	2	10
1 0	2	2	2	2	2	2	2	2	2	2	2	2	3	3	15
20	2	2	2	2	3	3	3	3	3	3	3	3	3	4	20
40	3	3	3	3	3	3	3	4	4	4	4	4	4	4	25
2 0	3	3	4	4	4	4	4	4	4	5	5	5	5	5	30
20	4	4	4	4	5	5	5	5	5	5	6	6	6	6	35
40	4	4	5	5	5	5	6	6	6	6	6	7	7	7	40
3 0	5	5	5	6	6	6	6	7	7	7	7	7	8	8	45
20	5	6	6	6	6	7	7	7	7	8	8	8	9	9	50
40	6	6	7	7	7	7	8	8	8	9	9	9	9	10	55
4 0	6	7	7	7	8	8	8	9	9	9	10	10	10	11	60
20	7	7	8	8	8	9	9	9	10	10	10	11	11	11	65
40	7	8	8	9	9	9	10	10	10	11	11	12	12	12	70
5 0	8	9	9	9	10	10	10	11	11	12	12	12	13	13	75
20	9	9	9	10	10	11	11	12	12	12	13	13	14	14	80
40	9	10	10	11	11	11	12	12	13	13	14	14	14	15	85
6 0	10	10	11	11	12	12	13	13	13	14	14	15	15	16	90
20	10	11	11	12	12	13	13	14	14	15	15	16	16	17	95
40	11	11	12	12	13	13	14	14	15	15	16	17	17	17	100
7 0	11	12	12	13	14	14	15	15	16	16	17	17	18	18	105
20	12	12	13	14	14	15	15	16	16	17	18	18	19	19	110
40	12	13	14	14	15	15	16	17	17	18	18	19	20	20	115
8 0	13	14	14	15	15	16	17	17	18	19	19	20	20	21	120
20	13	14	15	15	16	17	17	18	19	19	20	21	21	22	125
40	14	15	15	16	17	17	18	19	19	20	21	21	22	23	130
9 0	14	15	16	17	17	18	19	20	20	21	22	22	23	24	135
20	15	16	17	17	18	19	20	20	21	22	22	23	24	25	140
40	15	16	17	18	19	19	20	21	22	22	23	24	25	25	145
10 0	16	17	18	19	19	20	21	22	22	23	24	25	26	26	150
20	16	18	18	19	20	21	22	22	23	24	25	26	26	27	155
40	17	18	19	20	21	21	22	23	24	25	26	26	27	28	160
11 0	17	19	20	20	21	22	23	24	25	26	26	27	28	29	165
20	18	19	20	21	22	23	24	25	25	26	27	28	29	30	170
40	18	20	21	22	23	23	24	25	26	27	28	29	30	31	175
12 0	19	20	21	22	23	24	25	26	27	28	29	30	31	32	180

TABLE IV.

SEMIDIURNAL ARCS,

For finding the Time of the Rising and Setting of the Heavenly Bodies.

	Declination.															
Lat.	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	Lat.
°	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	°
1	6 00	6 00	6 00	6 00	6 00	6 00	6 00	6 01	6 01	6 01	6 01	6 01	6 01	6 01	6 01	1
3	6 00	6 00	6 00	6 01	6 01	6 01	6 01	6 02	6 02	6 02	6 02	6 02	6 03	6 03	6 03	3
5	6 00	6 01	6 01	6 01	6 02	6 02	6 02	6 03	6 03	6 04	6 04	6 04	6 05	6 05	6 05	5
7	6 00	6 01	6 01	6 02	6 02	6 03	6 03	6 04	6 04	6 05	6 05	6 06	6 06	6 07	6 08	7
9	6 01	6 01	6 02	6 02	6 03	6 04	6 04	6 05	6 06	6 06	6 07	6 08	6 08	6 09	6 10	9
11	6 01	6 02	6 02	6 03	6 04	6 05	6 05	6 06	6 07	6 08	6 09	6 09	6 10	6 11	6 12	11
13	6 01	6 02	6 03	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 14	13
14	6 01	6 02	6 03	6 04	6 05	6 06	6 07	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 15	14
15	6 01	6 02	6 03	6 04	6 05	6 06	6 08	6 09	6 10	6 11	6 12	6 13	6 14	6 15	6 16	15
16	6 01	6 02	6 03	6 05	6 06	6 07	6 08	6 09	6 10	6 12	6 13	6 14	6 15	6 16	6 18	16
17	6 01	6 02	6 04	6 05	6 06	6 07	6 09	6 10	6 11	6 12	6 14	6 15	6 16	6 17	6 19	17
18	6 01	6 03	6 04	6 05	6 07	6 08	6 09	6 10	6 12	6 13	6 14	6 16	6 17	6 19	6 20	18
19	6 01	6 03	6 04	6 06	6 07	6 08	6 10	6 11	6 13	6 14	6 15	6 17	6 18	6 20	6 21	19
20	6 01	6 03	6 04	6 06	6 07	6 09	6 10	6 12	6 13	6 15	6 16	6 18	6 19	6 21	6 22	20
21	6 02	6 03	6 05	6 06	6 08	6 09	6 11	6 12	6 14	6 16	6 17	6 19	6 20	6 22	6 24	21
22	6 02	6 03	6 05	6 06	6 08	6 10	6 11	6 13	6 15	6 16	6 18	6 20	6 21	6 23	6 25	22
23	6 02	6 03	6 05	6 07	6 09	6 10	6 12	6 14	6 15	6 17	6 19	6 21	6 22	6 24	6 26	23
24	6 02	6 04	6 05	6 07	6 09	6 11	6 13	6 14	6 16	6 18	6 20	6 22	6 24	6 26	6 27	24
25	6 02	6 04	6 06	6 07	6 09	6 11	6 13	6 15	6 17	6 19	6 21	6 23	6 25	6 27	6 29	25
26	6 02	6 04	6 06	6 08	6 10	6 12	6 14	6 16	6 18	6 20	6 22	6 24	6 26	6 28	6 30	26
27	6 02	6 04	6 06	6 08	6 10	6 12	6 14	6 16	6 19	6 21	6 23	6 25	6 27	6 29	6 31	27
28	6 02	6 04	6 06	6 09	6 11	6 13	6 15	6 17	6 19	6 22	6 24	6 26	6 28	6 30	6 33	28
29	6 02	6 04	6 07	6 09	6 11	6 13	6 16	6 18	6 20	6 22	6 25	6 27	6 29	6 32	6 34	29
30	6 02	6 05	6 07	6 09	6 12	6 14	6 16	6 19	6 21	6 23	6 26	6 28	6 31	6 33	6 36	30
31	6 02	6 05	6 07	6 10	6 12	6 14	6 17	6 19	6 22	6 24	6 27	6 29	6 32	6 34	6 37	31
32	6 02	6 05	6 08	6 10	6 13	6 15	6 18	6 20	6 23	6 25	6 28	6 31	6 33	6 36	6 39	32
33	6 03	6 05	6 08	6 10	6 13	6 16	6 18	6 21	6 24	6 26	6 29	6 32	6 34	6 37	6 40	33
34	6 03	6 05	6 08	6 11	6 14	6 16	6 19	6 22	6 25	6 27	6 30	6 33	6 36	6 39	6 42	34
35	6 03	6 06	6 08	6 11	6 14	6 17	6 20	6 23	6 25	6 28	6 31	6 34	6 37	6 40	6 43	35
36	6 03	6 06	6 09	6 12	6 15	6 18	6 20	6 23	6 26	6 29	6 32	6 36	6 39	6 42	6 45	36
37	6 03	6 06	6 09	6 12	6 15	6 18	6 21	6 24	6 27	6 31	6 34	6 37	6 40	6 43	6 47	37
38	6 03	6 06	6 09	6 13	6 16	6 19	6 22	6 25	6 28	6 32	6 35	6 38	6 42	6 45	6 48	38
39	6 03	6 06	6 10	6 13	6 16	6 20	6 23	6 26	6 29	6 33	6 36	6 40	6 43	6 47	6 50	39
40	6 03	6 07	6 10	6 13	6 17	6 20	6 24	6 27	6 31	6 34	6 38	6 41	6 45	6 48	6 52	40
41	6 03	6 07	6 10	6 14	6 17	6 21	6 25	6 28	6 32	6 35	6 39	6 43	6 46	6 50	6 54	41
42	6 04	6 07	6 11	6 14	6 18	6 22	6 25	6 29	6 33	6 37	6 40	6 44	6 48	6 52	6 56	42
43	6 04	6 07	6 11	6 15	6 19	6 22	6 26	6 30	6 34	6 38	6 42	6 46	6 50	6 54	6 58	43
44	6 04	6 08	6 12	6 15	6 19	6 23	6 27	6 31	6 35	6 39	6 43	6 47	6 52	6 56	7 00	44
45	6 04	6 08	6 12	6 16	6 20	6 24	6 28	6 32	6 36	6 41	6 45	6 49	6 53	6 58	7 02	45
46	6 04	6 08	6 12	6 17	6 21	6 25	6 29	6 33	6 38	6 42	6 46	6 51	6 55	7 00	7 04	46
47	6 04	6 09	6 13	6 17	6 22	6 26	6 30	6 35	6 39	6 44	6 48	6 53	6 57	7 02	7 07	47
48	6 04	6 09	6 13	6 18	6 22	6 27	6 31	6 36	6 41	6 45	6 50	6 55	6 59	7 04	7 09	48
49	6 05	6 09	6 14	6 18	6 23	6 28	6 32	6 37	6 42	6 47	6 52	6 57	7 02	7 07	7 12	49
50	6 05	6 10	6 14	6 19	6 24	6 29	6 34	6 39	6 44	6 49	6 54	6 59	7 04	7 09	7 14	50
51	6 05	6 10	6 15	6 20	6 25	6 30	6 35	6 40	6 45	6 50	6 56	7 01	7 06	7 12	7 17	51
52	6 05	6 10	6 15	6 21	6 26	6 31	6 36	6 41	6 47	6 52	6 58	7 03	7 09	7 14	7 20	52
53	6 05	6 11	6 16	6 21	6 27	6 32	6 38	6 43	6 49	6 54	7 00	7 06	7 11	7 17	7 23	53
54	6 06	6 11	6 17	6 22	6 28	6 33	6 39	6 45	6 50	6 56	7 02	7 08	7 14	7 20	7 27	54
55	6 06	6 11	6 17	6 23	6 29	6 35	6 40	6 46	6 52	6 58	7 04	7 11	7 17	7 23	7 30	55
56	6 06	6 12	6 18	6 24	6 30	6 36	6 42	6 48	6 54	7 01	7 07	7 13	7 20	7 27	7 34	56
57	6 06	6 12	6 19	6 25	6 31	6 37	6 44	6 50	6 56	7 03	7 10	7 16	7 23	7 30	7 37	57
58	6 06	6 13	6 19	6 26	6 32	6 39	6 45	6 52	6 59	7 06	7 13	7 20	7 27	7 34	7 42	58
59	6 07	6 13	6 20	6 27	6 33	6 40	6 47	6 54	7 01	7 08	7 16	7 23	7 30	7 38	7 46	59
60	6 07	6 14	6 21	6 28	6 35	6 42	6 49	6 56	7 04	7 11	7 19	7 26	7 34	7 42	7 51	60
61	6 07	6 14	6 22	6 29	6 36	6 44	6 51	6 59	7 06	7 14	7 22	7 30	7 38	7 47	7 56	61
62	6 08	6 15	6 23	6 30	6 38	6 46	6 53	7 01	7 09	7 17	7 26	7 34	7 43	7 52	8 01	62
63	6 08	6 16	6 24	6 32	6 40	6 48	6 56	7 04	7 12	7 21	7 30	7 39	7 48	7 57	8 07	63
64	6 08	6 16	6 25	6 33	6 41	6 50	6 58	7 07	7 16	7 25	7 34	7 43	7 53	8 03	8 13	64
65	6 09	6 17	6 26	6 34	6 43	6 52	7 01	7 10	7 19	7 29	7 39	7 48	7 59	8 09	8 20	65
66	6 09	6 18	6 27	6 36	6 45	6 55	7 04	7 14	7 23	7 33	7 42	7 54	8 05	8 16	8 28	66

Table IV.

Semidiurnal Arcs,

For finding the Time of the Rising and Setting of the Heavenly Bodies.

	Declination.															
Lat.	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	Lat.
°	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	°
1	6 01	6 01	6 01	6 01	6 01	6 02	6 02	6 02	6 02	6 02	6 02	6 02	6 02	6 02	6 02	1
3	6 03	6 04	6 04	6 04	6 04	6 05	6 05	6 05	6 05	6 06	6 06	6 06	6 06	6 07	6 07	3
5	6 06	6 06	6 07	6 07	6 07	6 08	6 08	6 09	6 09	6 09	6 10	6 10	6 11	6 11	6 12	5
7	6 08	6 09	6 09	6 10	6 10	6 11	6 11	6 12	6 13	6 13	6 14	6 14	6 15	6 16	6 16	7
9	6 10	6 11	6 12	6 13	6 13	6 14	6 15	6 15	6 16	6 17	6 18	6 19	6 19	6 20	6 21	9
11	6 13	6 14	6 14	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 22	6 23	6 24	6 25	6 26	11
13	6 15	6 16	6 17	6 18	6 19	6 20	6 21	6 22	6 24	6 25	6 26	6 27	6 28	6 29	6 31	13
14	6 16	6 17	6 19	6 20	6 21	6 22	6 23	6 24	6 25	6 27	6 28	6 29	6 30	6 32	6 33	14
15	6 18	6 19	6 20	6 21	6 22	6 24	6 25	6 26	6 27	6 29	6 30	6 31	6 33	6 34	6 36	15
16	6 19	6 20	6 21	6 23	6 24	6 25	.6 27	6 28	6 29	6 31	6 32	6 34	6 35	6 37	6 38	16
17	6 20	6 21	6 23	6 24	6 26	6 27	6 28	6 30	6 31	6 33	6 34	6 36	6 37	6 39	6 41	17
18	6 21	6 23	6 24	6 26	6 27	6 29	6 30	6 32	6 33	6 35	6 36	6 38	6 40	6 41	6 43	18
19	6 23	6 24	6 26	6 27	6 29	6 30	6 32	6 34	6 35	6 37	6 39	6 40	6 42	6 44	6 46	19
20	6 24	6 26	6 27	6 29	6 30	6 32	6 34	6 36	6 37	6 39	6 41	6 43	6 45	6 47	6 49	20
21	6 25	6 27	6 29	6 30	6 32	6 34	6 36	6 38	6 39	6 41	6 43	6 45	6 47	6 49	6 51	21
22	6 27	6 28	6 30	6 32	6 34	6 36	6 38	6 39	6 41	6 43	6 45	6 48	6 50	6 52	6 54	22
23	6 28	6 30	6 32	6 34	6 36	6 38	6 39	6 42	6 44	6 46	6 48	6 50	6 52	6 54	6 57	23
24	6 29	6 31	6 33	6 35	6 37	6 39	6 41	6 44	6 46	6 48	6 50	6 52	6 55	6 57	7 00	24
25	6 31	6 33	6 35	6 37	6 39	6 41	6 43	6 46	6 48	6 50	6 53	6 55	6 57	7 00	7 02	25
26	6 32	6 34	6 36	6 39	6 41	6 43	6 45	6 48	6 50	6 53	6 55	6 58	7 00	7 03	7 05	26
27	6 34	6 36	6 38	6 40	6 43	6 45	6 48	6 50	6 52	6 55	6 58	7 00	7 03	7 06	7 08	27
28	6 35	6 37	6 40	6 42	6 45	6 47	6 50	6 52	6 55	6 57	7 00	7 03	7 06	7 09	7 11	28
29	6 37	6 39	6 42	6 44	6 47	6 49	6 52	6 54	6 57	7 00	7 03	7 06	7 09	7 12	7 15	29
30	6 38	6 41	6 43	6 46	6 49	6 51	6 54	6 57	7 00	7 02	7 05	7 08	7 11	7 15	7 18	30
31	6 40	6 42	6 45	6 48	6 51	6 53	6 56	6 59	7 02	7 05	7 08	7 11	7 14	7 18	7 21	31
32	6 41	6 44	6 47	6 50	6 53	6 56	6 58	7 01	7 05	7 08	7 11	7 14	7 18	7 21	7 25	32
33	6 43	6 46	6 49	6 52	6 55	6 58	7 01	7 04	7 07	7 11	7 14	7 17	7 21	7 24	7 28	33
34	6 45	6 48	6 51	6 54	6 57	7 00	7 03	7 07	7 10	7 13	7 17	7 20	7 24	7 28	7 32	34
35	6 46	6 49	6 53	6 56	6 59	7 02	7 06	7 09	7 13	7 16	7 20	7 24	7 27	7 31	7 35	35
36	6 48	6 51	6 55	6 58	7 01	7 05	7 08	7 12	7 16	7 19	7 23	7 27	7 31	7 35	7 39	36
37	6 50	6 53	6 57	7 00	7 04	7 07	7 11	7 15	7 18	7 22	7 26	7 30	7 34	7 39	7 43	37
38	6 52	6 55	6 59	7 02	7 06	7 10	7 14	7 17	7 21	7 25	7 30	7 34	7 38	7 43	7 47	38
39	6 54	6 57	7 01	7 05	7 09	7 12	7 16	7 20	7 25	7 29	7 33	7 37	7 42	7 47	7 51	39
40	6 56	6 59	7 03	7 07	7 11	7 15	7 19	7 23	7 28	7 32	7 37	7 41	7 46	7 51	7 56	40
41	6 58	7 02	7 06	7 10	7 14	7 18	7 22	7 27	7 31	7 36	7 40	7 45	7 50	7 55	8 00	41
42	7 00	7 04	7 08	7 12	7 17	7 21	7 25	7 30	7 35	7 39	7 44	7 49	7 55	8 00	8 05	42
43	7 02	7 06	7 11	7 15	7 19	7 24	7 29	7 33	7 38	7 43	7 48	7 53	7 59	8 04	8 10	43
44	7 04	7 09	7 13	7 18	7 22	7 27	7 32	7 37	7 42	7 47	7 52	7 58	8 04	8 09	8 16	44
45	7 07	7 11	7 16	7 21	7 25	7 30	7 35	7 40	7 46	7 51	7 57	8 03	8 08	8 15	8 21	45
46	7 09	7 14	7 19	7 24	7 29	7 34	7 39	7 44	7 50	7 55	8 01	8 07	8 14	8 20	8 27	46
47	7 12	7 17	7 22	7 27	7 32	7 37	7 43	7 48	7 54	8 00	8 06	8 12	8 19	8 26	8 33	47
48	7 14	7 19	7 25	7 30	7 35	7 41	7 47	7 53	7 59	8 05	8 11	8 18	8 25	8 32	8 40	48
49	7 17	7 22	7 28	7 33	7 39	7 45	7 51	7 57	8 03	8 10	8 17	8 24	8 31	8 38	8 46	49
50	7 20	7 25	7 31	7 37	7 43	7 49	7 55	8 02	8 08	8 15	8 22	8 30	8 37	8 45	8 54	50
51	7 23	7 29	7 35	7 41	7 47	7 53	8 00	8 06	8 13	8 21	8 28	8 36	8 44	8 53	9 02	51
52	7 26	7 32	7 38	7 45	7 51	7 58	8 05	8 12	8 19	8 27	8 35	8 43	8 52	9 01	9 11	52
53	7 29	7 36	7 42	7 49	7 56	8 02	8 10	8 17	8 25	8 33	8 41	8 50	9 00	9 09	9 20	53
54	7 33	7 40	7 46	7 53	8 00	8 08	8 15	8 23	8 31	8 40	8 49	8 58	9 08	9 19	9 30	54
55	7 37	7 44	7 51	7 58	8 05	8 13	8 21	8 29	8 38	8 47	8 57	9 07	9 18	9 29	9 42	55
56	7 41	7 48	7 55	8 03	8 11	8 19	8 27	8 36	8 45	8 55	9 05	9 16	9 28	9 41	9 55	56
57	7 45	7 52	8 00	8 08	8 16	8 25	8 34	8 43	8 53	9 04	9 15	9 27	9 40	9 54	10 11	57
58	7 49	7 57	8 05	8 14	8 22	8 32	8 41	8 51	9 02	9 13	9 25	9 38	9 53	10 10	10 30	58
59	7 54	8 02	8 11	8 20	8 29	8 39	8 49	9 00	9 11	9 24	9 37	9 52	10 09	10 29	10 56	59
60	7 59	8 08	8 17	8 26	8 36	8 47	8 58	9 09	9 22	9 35	9 51	10 08	10 28	10 55	12 00	60
61	8 05	8 14	8 24	8 34	8 44	8 55	9 07	9 20	9 34	9 49	10 07	10 27	10 54	12 00		61
62	8 11	8 20	8 31	8 42	8 53	9 05	9 18	9 32	9 47	10 05	10 26	10 54	12 00			62
63	8 17	8 27	8 38	8 50	9 02	9 16	9 30	9 46	10 04	10 25	10 53	12 00				63
64	8 24	8 35	8 47	9 00	9 13	9 28	9 44	10 02	10 24	10 52	12 00					64
65	8 32	8 44	8 57	9 10	9 25	9 42	10 00	10 22	10 51	12 00						65
66	8 40	8 53	9 07	9 23	9 39	9 58	10 21	10 50	12 00							66

Table V.

Logarithm F.

Moon's Decl.	Moon's Horizontal Parallax.							
	53′·0.	53′·5.	54′·0.	54′·5.	55′·0.	55′·5.	56′·0.	56′·5.
0°	0·2757	0·2716	0·2676	0·2636	0·2596	0·2557	0·2518	0·2480
1	0·2757	0·2716	0·2675	0·2635	0·2596	0·2557	0·2517	0·2479
2	0·2755	0·2714	0·2673	0·2633	0·2594	0·2555	0·2515	0·2477
3	0·2751	0·2710	0·2670	0·2630	0·2590	0·2551	0·2512	0·2474
4	0·2747	0·2706	0·2665	0·2625	0·2586	0·2547	0·2508	0·2470
5	0·2741	0·2700	0·2659	0·2619	0·2580	0·2541	0·2502	0·2464
6	0·2733	0·2692	0·2652	0·2612	0·2573	0·2534	0·2494	0·2456
7	0·2725	0·2684	0·2644	0·2604	0·2564	0·2525	0·2486	0·2448
8	0·2715	0·2674	0·2634	0·2594	0·2554	0·2515	0·2476	0·2438
9	0·2703	0·2663	0·2622	0·2582	0·2543	0·2503	0·2464	0·2426
10	0·2691	0·2650	0·2610	0·2570	0·2530	0·2491	0·2452	0·2414
11	0·2677	0·2636	0·2596	0·2556	0·2516	0·2477	0·2438	0·2400
12	0·2661	0·2620	0·2580	0·2540	0·2500	0·2461	0·2422	0·2384
13	0·2644	0·2603	0·2563	0·2523	0·2484	0·2445	0·2405	0·2367
14	0·2626	0·2585	0·2545	0·2505	0·2465	0·2426	0·2387	0·2349
15	0·2607	0·2566	0·2525	0·2485	0·2446	0·2407	0·2368	0·2330
16	0·2586	0·2545	0·2505	0·2465	0·2425	0·2386	0·2347	0·2309
17	0·2563	0·2522	0·2482	0·2442	0·2402	0·2363	0·2324	0·2286
18	0·2539	0·2498	0·2458	0·2418	0·2378	0·2339	0·2300	0·2262
19	0·2514	0·2473	0·2433	0·2393	0·2353	0·2314	0·2275	0·2236
20	0·2487	0·2446	0·2406	0·2366	0·2326	0·2287	0·2248	0·2210
21	0·2459	0·2418	0·2378	0·2338	0·2298	0·2259	0·2220	0·2182
22	0·2429	0·2388	0·2348	0·2308	0·2268	0·2229	0·2190	0·2152
23	0·2398	0·2357	0·2316	0·2276	0·2237	0·2198	0·2158	0·2120
24	0·2365	0·2324	0·2283	0·2243	0·2204	0·2165	0·2125	0·2087
25	0·2330	0·2289	0·2249	0·2209	0·2169	0·2130	0·2091	0·2053
26	0·2294	0·2253	0·2213	0·2173	0·2133	0·2094	0·2055	0·2017
27	0·2256	0·2215	0·2175	0·2135	0·2095	0·2056	0·2017	0·1979
28	0·2217	0·2176	0·2135	0·2095	0·2056	0·2017	0·1977	0·1939
29	0·2175	0·2135	0·2094	0·2054	0·2015	0·1975	0·1936	0·1898

Table V.

Logarithm F.

Moon's Decl.	Moon's Horizontal Parallax.								
	57'·0.	57'·5.	58'·0.	58'·5.	59'·0.	59'·5.	60'·0.	60'·5.	61'·0.
0°	0·2441	0·2403	0·2366	0·2328	0·2291	0·2255	0·2218	0·2182	0·2147
1	0·2441	0·2403	0·2365	0·2328	0·2291	0·2255	0·2218	0·2182	0·2146
2	0·2439	0·2401	0·2363	0·2326	0·2289	0·2252	0·2216	0·2180	0·2144
3	0·2435	0·2397	0·2360	0·2323	0·2286	0·2249	0·2213	0·2177	0·2141
4	0·2431	0·2393	0·2355	0·2318	0·2281	0·2244	0·2208	0·2172	0·2136
5	0·2425	0·2387	0·2349	0·2312	0·2275	0·2238	0·2202	0·2166	0·2130
6	0·2417	0·2379	0·2342	0·2305	0·2268	0·2231	0·2195	0·2159	0·2123
7	0·2409	0·2371	0·2333	0·2296	0·2259	0·2222	0·2186	0·2150	0·2114
8	0·2399	0·2361	0·2323	0·2286	0·2249	0·2212	0·2176	0·2140	0·2104
9	0·2387	0·2350	0·2312	0·2275	0·2238	0·2201	0·2165	0·2129	0·2093
10	0·2375	0·2337	0·2299	0·2262	0·2225	0·2188	0·2152	0·2116	0·2080
11	0·2361	0·2323	0·2285	0·2248	0·2211	0·2174	0·2138	0·2102	0·2066
12	0·2345	0·2307	0·2270	0·2233	0·2196	0·2159	0·2123	0·2087	0·2051
13	0·2328	0·2290	0·2253	0·2216	0·2179	0·2142	0·2106	0·2070	0·2034
14	0·2310	0·2272	0·2235	0·2198	0·2161	0·2124	0·2088	0·2052	0·2016
15	0·2291	0·2253	0·2215	0·2178	0·2141	0·2104	0·2068	0·2032	0·1996
16	0·2270	0·2232	0·2194	0·2157	0·2120	0·2083	0·2047	0·2011	0·1975
17	0·2247	0·2209	0·2172	0·2135	0·2097	0·2060	0·2024	0·1988	0·1953
18	0·2223	0·2185	0·2148	0·2111	0·2074	0·2037	0·2001	0·1965	0·1929
19	0·2198	0·2160	0·2122	0·2085	0·2048	0·2012	0·1975	0·1939	0·1903
20	0·2171	0·2133	0·2096	0·2059	0·2021	0·1984	0·1948	0·1912	0·1877
21	0·2143	0·2105	0·2067	0·2030	0·1993	0·1956	0·1920	0·1884	0·1848
22	0·2113	0·2075	0·2037	0·2000	0·1963	0·1926	0·1890	0·1854	0·1818
23	0·2082	0·2044	0·2006	0·1969	0·1932	0·1895	0·1859	0·1823	0·1787
24	0·2049	0·2011	0·1973	0·1936	0·1899	0·1862	0·1826	0·1790	0·1754
25	0·2014	0·1976	0·1938	0·1901	0·1864	0·1827	0·1791	0·1755	0·1719
26	0·1978	0·1939	0·1902	0·1865	0·1828	0·1791	0·1755	0·1719	0·1683
27	0·1940	0·1902	0·1865	0·1828	0·1790	0·1753	0·1717	0·1681	0·1646
28	0·1901	0·1863	0·1825	0·1788	0·1751	0·1714	0·1678	0·1642	0·1606
29	0·1859	0·1821	0·1784	0·1747	0·1710	0·1673	0·1637	0·1601	0·1565

TABLE VI.

Hour Angle at true Conj.	Logarithm K.	Number N.	Hour Angle at true Conj.	Logarithm K.	Number N.
h m			h m		
0 0	0·0000	26·26	0 45	3·0684	25·75
1	1·4180	26·25	46	3·0778	25·72
2	1·7190	26·25	47	3·0870	25·70
3	1·8951	26·25	48	3·0960	25·68
4	2·0200	26·25	49	3·1049	25·65
5	2·1169	26·25	50	3·1135	25·63
6	2·1961	26·24	51	3·1219	25·60
7	2·2630	26·24	52	3·1302	25·58
8	2·3210	26·24	53	3·1384	25·55
9	2·3721	26·23	54	3·1463	25·53
10	2·4178	26·23	55	3·1542	25·50
11	2·4592	26·22	56	3·1618	25·47
12	2·4970	26·22	57	3·1694	25·44
13	2·5317	26·21	58	3·1768	25·42
14	2·5638	26·20	0 59	3·1840	25·39
15	2·5937	26·20	1 0	3·1911	25·36
16	2·6217	26·19	1	3·1982	25·33
17	2·6480	26·18	2	3·2050	25·30
18	2·6728	26·17	3	3·2118	25·27
19	2·6962	26·16	4	3·2185	25·23
20	2·7184	26·15	5	3·2250	25·20
21	2·7396	26·14	6	3·2315	25·17
22	2·7597	26·13	7	3·2378	25·14
23	2·7790	26·12	8	3·2441	25·10
24	2·7974	26·11	9	3·2502	25·07
25	2·8150	26·10	10	3·2563	25·04
26	2·8320	26·08	11	3·2623	25·00
27	2·8483	26·07	12	3·2681	24·97
28	2·8640	26·06	13	3·2739	24·93
29	2·8792	26·04	14	3·2796	24·89
30	2·8938	26·03	15	3·2852	24·86
31	2·9080	26·01	16	3·2908	24·82
32	2·9217	26·00	17	3·2963	24·78
33	2·9350	25·98	18	3·3016	24·75
34	2·9479	25·96	19	3·3070	24·71
35	2·9603	25·95	20	3·3122	24·67
36	2·9725	25·93	21	3·3174	24·63
37	2·9843	25·91	22	3·3225	24·59
38	2·9958	25·89	23	3·3275	24·55
39	3·0069	25·87	24	3·3325	24·51
40	3·0178	25·85	25	3·3374	24·47
41	3·0284	25·83	26	3·3422	24·42
42	3·0388	25·81	27	3·3470	24·38
43	3 0489	25·79	28	3·3517	24·34
0 44	3·0588	25·77	1 29	3·3564	24·30

Hour Angle at true Conj.	Logarithm K.	Number N.	Hour Angle at true Conj.	Logarithm K.	Number N.
h m			h m		
1 30	3·3610	24·25	2 15	3·5229	21·83
31	3·3655	24·21	16	3·5257	21·76
32	3·3700	24·16	17	3·5285	21·70
33	3·3745	24·12	18	3·5313	21·63
34	3·3789	24·07	19	3·5340	21·57
35	3·3832	24·03	20	3·5367	21·50
36	3·3875	23·98	21	3·5394	21·44
37	3·3917	23·93	22	3·5421	21·37
38	3·3959	23·89	23	3·5447	21·30
39	3·4000	23·84	24	3·5474	21·24
40	3·4041	23·79	25	3·5500	21·17
41	3·4081	23·74	26	3·5525	21·10
42	3·4121	23·69	27	3·5551	21·03
43	3·4161	23·64	28	3·5576	20·97
44	3·4200	23·59	29	3·5601	20·90
45	3·4239	23·54	30	3·5626	20·83
46	3·4277	23·49	31	3·5651	20·76
47	3·4315	23·44	32	3·5675	20·69
48	3·4352	23·39	33	3·5699	20·62
49	3·4389	23·34	34	3·5723	20·54
50	3·4426	23·29	35	3·5747	20·47
51	3·4462	23·23	36	3·5770	20·40
52	3·4498	23·18	37	3·5794	20·33
53	3·4533	23·12	38	3·5817	20·26
54	3·4568	23·07	39	3·5839	20·18
55	3·4603	23·02	40	3·5862	20·11
56	3·4637	22·96	41	3·5885	20·04
57	3·4671	22·90	42	3·5907	19·96
58	3·4705	22·85	43	3·5929	19·89
1 59	3·4738	22·79	44	3·5951	19·81
2 0	3·4771	22·73	45	3·5973	19·74
1	3·4804	22·68	46	3·5994	19·66
2	3·4836	22·62	47	3·6015	19·58
3	3·4868	22·56	48	3·6037	19·51
4	3·4900	22·50	49	3·6058	19·43
5	3·4931	22·44	50	3·6078	19·35
6	3·4962	22·38	51	3·6099	19·28
7	3·4993	22·32	52	3·6119	19·20
8	3·5024	22·26	53	3·6140	19·12
9	3·5054	22·20	54	3·6160	19·04
10	3·5084	22·14	55	3·6180	18·96
11	3·5113	22·08	56	3·6199	18·88
12	3·5143	22·02	57	3·6219	18·80
13	3·5172	21·95	58	3·6238	18·72
2 14	3·5200	21·89	2 59	3·6257	18·64

Moon's Appt. Decl.	Latitude. 0° A.	0° E.	1° A.	1° E.	2° A.	2° E.	3° A.	3° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	0·00	0·00	0·99	0·00	1·98	0·00	2·96	0·00	0
1	0·00	0·99	0·99	0·99	1·98	0·99	2·96	0·99	1
2	0·00	1·99	0·99	1·99	1·98	1·99	2·96	1·99	2
3	0·00	2·98	0·99	2·98	1·97	2·98	2·96	2·98	3
4	0·00	3·98	0·99	3·98	1·97	3·97	2·96	3·97	4
5	0·00	4·97	0·98	4·97	1·97	4·96	2·95	4·96	5
6	0·00	5·96	0·98	5·96	1·97	5·95	2·95	5·95	6
7	0 00	6·95	0·98	6·95	1·96	6·94	2·94	6·94	7
8	0·00	7·93	0·98	7·93	1·96	7·93	2·93	7·92	8
9	0·00	8·92	0·98	8·92	1·95	8·91	2·93	8·90	9
10	0·00	9·90	0·97	9·90	1·95	9·89	2·92	9·88	10
11	0·00	10·88	0·97	10·87	1·94	10·87	2·91	10·86	11
12	0·00	11·85	0·97	11·85	1·93	11·85	2·90	11·84	12
13	0·00	12·82	0·96	12·82	1·93	12·81	2·89	12·80	13
14	0·00	13·79	0·96	13·79	1·92	13·78	2·88	13·77	14
15	0·00	14·75	0·95	14·75	1·91	14·74	2·86	14·73	15
16	0·00	15·71	0·95	15·71	1·90	15·70	2·85	15·69	16
17	0·00	16·66	0·94	16·66	1·89	16·66	2·83	16·64	17
18	0·00	17·61	0·94	17·61	1·88	17·60	2·82	17·59	18
19	0·00	18·56	0·93	18·55	1·87	18·55	2·80	18·53	19
20	0·00	19·50	0·93	19·49	1·86	19·48	2·78	19·47	20
21	0·00	20·43	0·92	20·42	1·85	20·41	2·77	20·40	21
22	0·00	21·35	0·92	21·35	1·83	21·34	2·75	21·32	22
23	0·00	22·27	0·91	22·27	1·82	22·26	2·73	22·24	23
24	0·00	23·18	0·90	23·18	1·81	23·17	2·71	23·15	24
25	0·00	24·09	0·90	24·09	1·79	24·07	2·69	24·06	25
26	0·00	24·99	0·89	24·98	1·78	24·97	2·66	24·95	26
27	0·00	25·88	0·88	25·87	1·76	25·86	2·64	25·84	27
28	0·00	26·76	0·87	26·76	1·74	26·74	2·62	26·72	28
29	0·00	27·63	0·86	27·63	1·73	27·62	2·59	27·60	29
30	0·00	28·50	0·86	28·50	1·71	28·48	2·57	28·46	30
Moon's H.P.	**I.**	**Diff.**	**I.**	**Diff.**	**I.**	**Diff.**	**I.**	**Diff.**	**Moon's H.P.**
53′	53·0		52·99		52·97		52·93		53′
54	54·0		53·99		53·97		53·93		54
55	55·0		54·99		54·97		54·93		55
56	56·0		55·99		55·97		55·93		56
57	57·0	1·00	56·99	1·00	56·97	1·00	56·92	1·00	57
58	58·0		57·99		57·97		57·92		58
59	59·0		58·99		58·97		58·92		59
60	60·0		59·99		59·97		59·92		60
61	61·0		60·99		60·96		60·92		61

Moon's Appt. Decl.	Latitude. 4° A.	4° E.	5° A.	5° E.	6° A.	6° E.	7° A.	7° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	3·95	0·00	4·94	0·00	5·92	0·00	6·90	0·00	0
1	3·95	0·99	4·93	0·99	5·92	0·99	6·90	0·99	1
2	3·95	1·98	4·93	1·98	5·92	1·98	6·90	1·97	2
3	3·94	2·98	4·93	2·97	5·91	2·97	6·89	2·96	3
4	3·94	3·97	4·92	3·96	5·90	3·95	6·88	3·95	4
5	3·94	4·96	4·92	4·95	5·90	4·94	6·87	4·93	5
6	3·93	5·94	4·91	5·94	5·89	5·93	6·86	5·91	6
7	3·92	6·93	4·90	6·92	5·87	6·91	6·85	6·90	7
8	3·91	7·91	4·89	7·90	5·86	7·89	6·83	7·87	8
9	3·90	8·89	4·87	8·88	5·85	8·87	6·82	8·85	9
10	3·89	9·87	4·86	9·86	5·83	9·84	6·80	9·82	10
11	3·88	10·85	4·84	10·84	5·81	10·82	6·77	10·80	11
12	3·86	11·82	4·83	11·81	5·79	11·79	6·75	11·76	12
13	3·85	12·79	4·81	12·77	5·77	12·75	6·72	12·73	13
14	3·83	13·76	4·79	13·74	5·74	13·71	6·70	13·69	14
15	3·82	14·72	4·77	14·70	5·72	14·67	6·67	14·64	15
16	3·80	15·67	4·74	15·65	5·69	15·63	6·63	15·59	16
17	3·78	16·62	4·72	16·60	5·66	16·57	6·60	16·54	17
18	3·76	17·57	4·69	17·55	5·63	17·52	6·56	17·48	18
19	3·74	18·51	4·67	18·49	5·60	18·46	6·53	18·42	19
20	3·71	19·45	4·64	19·42	5·56	19·39	6·49	19·35	20
21	3·69	20·38	4·61	20·35	5·53	20·32	6·44	20·28	21
22	3·66	21·30	4·58	21·27	5·49	21·24	6·40	21·19	22
23	3·64	22·22	4·54	22·19	5·45	22·15	6·35	22·11	23
24	3·61	23·13	4·51	23·10	5·41	23·06	6·30	23·01	24
25	3·58	24·03	4·47	24·00	5·36	23·96	6·25	23·91	25
26	3·55	24·93	4·44	24·89	5·32	24·85	6·20	24·80	26
27	3·52	25·81	4·40	25·78	5·27	25·74	6·15	25·69	27
28	3·49	26·70	4·36	26·66	5·23	26·61	6·09	26·56	28
29	3·46	27·57	4·32	27·53	5·18	27·48	6·04	27·43	29
30	3·42	28·43	4·27	28·39	5·13	28·34	5·98	28·29	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	52·87		52·80		52·71		52·61		53′
54	53·87		53·80		53·71		53·61		54
55	54·87		54·79		54·70		54·60		55
56	55·87		55·79		55·70		55·59		56
57	56·86	1·00	56·78	1·00	56·69	1·00	56·58	0·99	57
58	57·86		57·78		57·69		57·58		58
59	58·86		58·78		58·68		58·57		59
60	59·86		59·78		59·68		59·56		60
61	60·85		60·77		60·67		60·55		61

TABLE VII.

Moon's Appt. Decl.	Latitude. 8° A.	8° E.	9° A.	9° E.	10° A.	10° E.	11° A.	11° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	7·88	0·00	8·86	0·00	9·83	0·00	10·81	0·00	0
1	7·88	0·99	8·86	0·98	9·83	0·98	10·80	0·98	1
2	7·88	1·97	8·85	1·96	9·83	1·96	10·80	1·95	2
3	7·87	2·95	8·85	2·95	9·82	2·94	10·79	2·93	3
4	7·86	3·94	8·84	3·93	9·81	3·92	10·78	3·90	4
5	7·85	4·92	8·83	4·91	9·80	4·89	10·76	4·88	5
6	7·84	5·90	8·81	5·89	9·78	5·87	10·75	5·85	6
7	7·82	6·88	8·79	6·86	9·76	6·84	10·73	6·82	7
8	7·80	7·86	8·77	7·84	9·74	7·81	10·70	7·79	8
9	7·78	8·83	8·75	8·81	9·71	8·78	10·67	8·75	9
10	7·76	9·80	8·72	9·78	9·68	9·75	10·64	9·72	10
11	7·74	10·77	8·70	10·74	9·65	10·71	10·61	10·68	11
12	7·71	11·74	8·67	11·71	9·62	11·67	10·57	11·63	12
13	7·68	12·70	8·63	12·67	9·58	12·63	10·53	12·59	13
14	7·65	13·66	8·60	13·62	9·54	13·58	10·48	13·54	14
15	7·61	14·61	8·56	14·57	9·50	14·53	10·44	14·48	15
16	7·58	15·56	8·52	15·52	9·45	15·47	10·39	15·42	16
17	7·54	16·50	8·47	16·46	9·40	16·41	10·33	16·36	17
18	7·50	17·44	8·43	17·40	9·35	17·35	10·28	17·29	18
19	7·45	18·38	8·38	18·33	9·30	18·28	10·22	18·22	19
20	7·41	19·31	8·32	19·26	9·24	19·20	10·15	19·14	20
21	7·36	20·23	8·27	20·18	9·18	20·12	10·09	20·05	21
22	7·31	21·15	8·21	21·09	9·12	21·03	10·02	20·96	22
23	7·25	22·06	8·15	22·00	9·05	21·94	9·95	21·87	23
24	7·20	22·96	8·09	22·90	8·98	22·83	9·87	22·76	24
25	7·14	23·86	8·03	23·79	8·91	23·73	9·79	23·65	25
26	7·08	24·75	7·96	24·68	8·84	24·61	9·71	24·53	26
27	7·02	25·63	7·89	25·56	8·76	25·49	9·63	25·41	27
28	6·96	26·50	7·82	26·43	8·68	26·36	9·54	26·27	28
29	6·89	27·37	7·75	27·30	8·60	27·22	9·45	27·13	29
30	6·83	28·22	7·67	28·15	8·52	28·07	9·36	27·98	30

Moon's H.P.	8° I.	Diff.	9° I.	Diff.	10° I.	Diff.	11° I.	Diff.	Moon's H.P.
53′	52·49		52·35		52·20		52·03		53′
54	53·48		53·34		53·18		53·01		54
55	54·47		54·33		54·17		53·99		55
56	55·46		55·31		55·15		54·97		56
57	56·45	0·99	56·30	0·99	56·14	0·98	55·96	0·98	57
58	57·44		57·29		57·12		56·94		58
59	58·43		58·28		58·11		57·92		59
60	59·42		59·26		59·09		58·90		60
61	60·41		60·25		60·08		59·89		61

Moon's Appt. Decl.	Latitude. 12° A.	12° E.	13° A.	13° E.	14° A.	14° E.	15° A.	15° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	11·77	0·00	12·74	0·00	13·70	0·00	14·66	0·00	0
1	11·77	0·97	12·74	0·97	13·70	0·97	14·66	0·96	1
2	11·77	1·95	12·73	1·94	13·69	1·93	14·65	1·92	2
3	11·76	2·92	12·72	2·91	13·68	2·90	14·64	2·88	3
4	11·75	3·89	12·71	3·87	13·67	3·86	14·62	3·84	4
5	11·73	4·86	12·69	4·84	13·65	4·82	14·60	4·80	5
6	11·71	5·83	12·67	5·81	13·63	5·78	14·58	5·76	6
7	11·69	6·80	12·65	6·77	13·60	6·74	14·55	6·71	7
8	11·66	7·76	12·62	7·73	13·57	7·70	14·52	7·66	8
9	11·63	8·72	12·58	8·69	13·53	8·65	14·48	8·61	9
10	11·60	9·68	12·55	9·65	13·49	9·61	14·44	9·56	10
11	11·56	10·64	12·51	10·60	13·45	10·56	14·39	10·51	11
12	11·52	11·59	12·46	11·55	13·40	11·50	14·34	11·45	12
13	11·47	12·54	12·41	12·50	13·35	12·44	14·28	12·39	13
14	11·42	13·49	12·36	13·44	13·29	13·38	14·22	13·32	14
15	11·37	14·43	12·31	14·38	13·23	14·32	14·16	14·25	15
16	11·32	15·37	12·25	15·31	13·17	15·25	14·09	15·18	16
17	11·26	16·30	12·18	16·24	13·10	16·17	14·02	16·10	17
18	11·19	17·23	12·11	17·16	13·03	17·09	13·94	17·02	18
19	11·13	18·15	12·05	18·09	12·96	18·01	13·86	17·93	19
20	11·06	19·07	11·97	19·00	12·88	18·92	13·77	18·84	20
21	10·99	19·98	11·89	19·91	12·79	19·82	13·69	19·74	21
22	10·92	20·89	11·81	20·81	12·70	20·72	13·59	20·63	22
23	10·84	21·79	11·73	21·70	12·61	21·61	13·49	21·52	23
24	10·76	22·68	11·64	22·59	12·52	22·50	13·28	22·40	24
25	10·67	23·57	11·55	23·48	12·42	23·38	13·39	23·27	25
26	10·58	24·44	11·45	24·35	12·31	24·25	13·18	24·14	26
27	10·49	25·32	11·35	25·22	12·21	25·11	13·06	25·00	27
28	10·40	26·18	11·25	26·08	12·10	25·97	12·94	25·85	28
29	10·30	27·03	11·14	26·93	11·98	26·82	12·82	26·70	29
30	10·20	27·88	11·03	27·77	11·87	27·66	12·70	27·53	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	51·85		51·65		51·44		51·21		53′
54	52·83		52·63		52·41		52·18		54
55	53·81		53·60		53·38		53·14		55
56	54·79		54 58		54·35		54·11		56
57	55·76	0·98	55·55	0·98	55·32	0·97	55·07	0·97	57
58	56·74		56·53		56·29		56·04		58
59	57·72		57·50		57·26		57·00		59
60	58·70		58·48		58·23		57·97		60
61	59·68		59·45		59·20		58·93		61

Table VII.

Moon's Appt. Decl.	Latitude. 16° A.	16° E.	17° A.	17° E.	18° A.	18° E.	19° A.	19° E.	Moon's Appt. Decl.
0°	15′·61	0′·00	16′·56	0′·00	17′·50	0′·00	18′·44	0′·00	0°
1	15·61	0·96	16·56	0·95	17·50	0·95	18·44	0·94	1
2	15·60	1·91	16·55	1·90	17·49	1·89	18·43	1·88	2
3	15·59	2·87	16·54	2·85	17·48	2·84	18·42	2·82	3
4	15·57	3·82	16·52	3·80	17·46	3·78	18·40	3·76	4
5	15·55	4·78	16·50	4·75	17·44	4·73	18·37	4·70	5
6	15·53	5·73	16·47	5·70	17·41	5·67	18·34	5·64	6
7	15·50	6·68	16·44	6·64	17·37	6·61	18·31	6·57	7
8	15·46	7·63	16·40	7·59	17·33	7·55	18·26	7·50	8
9	15·42	8·57	16·36	8·53	17·29	8·48	18·21	8·43	9
10	15·37	9·52	16·31	9·47	17·24	9·42	18·16	9·36	10
11	15·33	10·46	16·26	10·40	17·18	10·35	18·10	10·29	11
12	15·27	11·39	16·20	11·34	17·12	11·28	18·04	11·21	12
13	15·21	12·33	16·14	12·27	17·05	12·20	17·97	12·13	13
14	15·15	13·26	16·07	13·19	16·98	13·12	17·89	13·04	14
15	15·08	14·18	16·00	14·11	16·91	14·04	17·81	13·95	15
16	15·01	15·11	15·92	15·03	16·82	14·95	17·73	14·86	16
17	14·93	16·02	15·84	15·94	16·74	15·85	17·64	15·76	17
18	14·85	16·94	15·75	16·85	16·65	16·76	17·54	16·66	18
19	14·76	17·84	15·66	17·75	16·55	17·65	17·44	17·55	19
20	14·67	18·74	15·56	18·65	16·45	18·55	17·33	18·44	20
21	14·58	19·64	15·46	19·54	16·34	19·43	17·22	19·32	21
22	14·48	20·53	15·35	20·43	16·23	20·31	17·10	20·20	22
23	14·37	21·41	15·24	21·30	16·11	21·19	16·98	21·07	23
24	14·26	22·29	15·13	22·18	15·99	22·06	16·85	21·93	24
25	14·15	23·16	15·01	23·04	15·86	22·92	16·71	22·78	25
26	14·03	24·03	14·88	23·90	15·73	23·77	16·58	23·63	26
27	13·91	24·88	14·76	24·75	15·60	24·62	16·43	24·48	27
28	13·78	25·73	14·62	25·60	15·46	25·46	16·28	25·31	28
29	13·65	26·57	14·48	26·43	15·31	26·29	16·13	26·14	29
30	13·52	27·40	14·34	27·26	15·16	27·11	15·97	26·96	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	50·96		50·70		50·42		50·13		53′
54	51·92		51·66		51·37		51·08		54
55	52·88		52·61		52·32		52·02		55
56	53·84		53·57		53·27		52·97		56
57	54·81	0·96	54·52	0·96	54·23	0·95	53·91	0·95	57
58	55·77		55·48		55·18		54·86		58
59	56·73		56·44		56·13		55·80		59
60	57·69		57·39		57·08		56·75		60
61	58·65		58·35		58·03		57·70		61

Moon's Appt. Decl.	Latitude 20°		21°		22°		23°		Moon's Appt. Decl.
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	19·37	0·00	20·30	0·00	21·22	0·00	22·14	0·00	0
1	19·37	0·94	20·30	0·93	21·22	0·92	22·13	0·92	1
2	19·36	1·87	20·29	1·86	21·21	1·85	22·12	1·83	2
3	19·35	2·80	20·27	2·79	21·19	2·77	22·11	2·75	3
4	19·33	3·74	20·25	3·71	21·17	3·69	22·08	3·66	4
5	19·30	4·67	20·22	4·64	21·14	4·61	22·05	4·58	5
6	19·27	5·60	20·19	5·56	21·11	5·53	22·02	5·49	6
7	19·23	6·53	20·15	6·49	21·06	6·44	21·97	6·40	7
8	19·19	7·46	20·10	7·41	21·02	7·36	21·92	7·31	8
9	19·14	8·38	20·05	8·33	20·96	8·27	21·86	8·21	9
10	19·08	9·30	19·99	9·24	20·90	9·18	21·80	9·12	10
11	19·02	10·22	19·93	10·16	20·83	10·09	21·73	10·02	11
12	18·95	11·14	19·86	11·07	20·76	10·99	21·65	10·91	12
13	18·88	12·05	19·78	11·98	20·68	11·90	21·57	11·81	13
14	18·80	12·96	19·70	12·88	20·59	12·79	21·48	12·70	14
15	18·71	13·87	19·61	13·78	20·50	13·68	21·38	13·59	15
16	18·62	14·77	19·52	14·67	20·40	14·57	21·28	14·47	16
17	18·53	15·67	19·41	15·56	20·29	15·46	21·17	15·35	17
18	18·43	16·56	19·31	16·45	20·18	16·34	21·05	16·22	18
19	18·32	17·44	19·20	17·33	20·07	17·21	20·93	17·09	19
20	18·21	18·33	19·08	18·21	19·94	18·08	20·80	17·95	20
21	18·09	19·20	18·95	19·08	19·81	18·95	20·67	18·81	21
22	17·96	20·07	18·82	19·94	19·68	19·81	20·52	19·66	22
23	17·83	20·94	18·69	20·80	19·54	20·66	20·38	20·51	23
24	17·70	21·79	18·55	21·65	19·39	21·51	20·22	21·35	24
25	17·56	22·65	18·40	22·50	19·23	22·35	20·06	22·19	25
26	17·41	23·49	18·25	23·34	19·07	23·18	19·90	23·01	26
27	17·26	24·33	18·09	24·17	18·91	24·00	19·72	23·83	27
28	17·11	25·16	17·92	24·99	18·74	24·82	19·55	24·64	28
29	16·95	25·98	17·76	25·81	18·56	25·63	19·36	25·45	29
30	16·78	26·79	17·58	26·62	18·38	26·44	19·17	26·25	30
Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	49·82		49·50		49·16		48·81		53′
54	50·76		50·43		50·09		49·73		54
55	51·70		51·37		51·02		50·65		55
56	52·64		52·30		51·95		51·57		56
57	53·58	0·94	53·24	0·93	52·87	0·93	52·50	0·92	57
58	54·52		54·17		53·80		53·42		58
59	55·46		55·11		54·73		54·34		59
60	56·40		56·04		55·66		55·26		60
61	57·34		56·97		56·58		56·18		61

Moon's Appt. Decl.	Latitude. 24° A.	24° E.	25° A.	25° E.	26° A.	26° E.	27° A.	27° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	23·04	0·00	23·95	0·00	24·84	0·00	25·73	0·00	0
1	23·04	0·91	23·94	0·90	24·84	0·89	25·72	0·89	1
2	23·03	1·82	23·93	1·80	24·82	1·79	25·71	1·77	2
3	23·02	2·73	23·91	2·71	24·80	2·68	25·69	2·66	3
4	22·99	3·63	23·89	3·61	24·78	3·58	25·66	3·55	4
5	22·96	4·54	23·85	4·51	24·74	4·47	25·63	4·43	5
6	22·92	5·45	23·81	5·40	24·70	5·36	25·58	5·31	6
7	22·87	6·35	23·77	6·30	24·65	6·25	25·53	6·19	7
8	22·82	7·25	23·71	7·19	24·60	7·13	25·47	7·07	8
9	22·76	8·15	23·65	8·09	24·53	8·02	25·41	7·95	9
10	22·69	9·05	23·58	8·98	24·46	8·90	25·33	8·83	10
11	22·62	9·94	23·50	9·86	24·38	9·78	25·25	9·70	11
12	22·54	10·83	23·42	10·75	24·30	10·66	25·16	10·57	12
13	22·45	11·72	23·33	11·63	24·20	11·53	25·07	11·43	13
14	22·36	12·60	23·23	12·50	24·10	12·40	24·96	12·29	14
15	22·26	13·48	23·13	13·38	23·99	13·27	24·85	13·15	15
16	22·15	14·36	23·02	14·25	23·88	14·13	24·73	14·01	16
17	22·04	15·23	22·90	15·11	23·75	14·99	24·60	14·86	17
18	21·92	16·10	22·77	15·97	23·62	15·84	24·47	15·70	18
19	21·79	16·96	22·64	16·83	23·49	16·69	24·32	16·55	19
20	21·65	17·82	22·50	17·68	23·34	17·53	24·17	17·38	20
21	21·51	18·67	22·35	18·52	23·19	18·37	24·02	18·21	21
22	21·37	19·52	22·20	19·36	23·03	19·20	23·85	19·04	22
23	21·21	20·36	22·04	20·20	22·86	20·03	23·68	19·86	23
24	21·05	21·19	21·88	21·02	22·69	20·85	23·50	20·67	24
25	20·89	22·02	21·70	21·85	22·51	21·67	23·31	21·48	25
26	20·71	22·84	21·52	22·66	22·33	22·47	23·12	22·28	26
27	20·53	23·65	21·34	23·47	22·13	23·27	22·92	23·07	27
28	20·35	24·46	21·14	24·27	21·93	24·07	22·71	23·86	28
29	20·16	25·26	20·94	25·06	21·72	24·85	22·50	24·64	29
30	19·96	26·05	20·74	25·84	21·51	25·63	22·28	25·41	30

Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	48·44		48·06		47·67		47·25		53′
54	49·36		48·97		48·57		48·14		54
55	50·27		49·88		49·47		49·03		55
56	51·19		50·79		50·37		49·92		56
57	52·10	0·92	51·69	0·91	51·26	0·90	50·82	0·89	57
58	53·02		52·60		52·16		51·71		58
59	53·93		53·51		53·06		52·60		59
60	54·85		54·42		53·96		53·49		60
61	55·76		55·32		54·86		54·39		61

Moon's Appt. Decl.	Latitude. 28° A.	28° E.	29° A.	29° E.	30° A.	30° E.	31° A.	31° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	26·60	0·00	27·47	0·00	28·34	0·00	29·19	0·00	0
1	26·60	0·88	27·47	0·87	28·33	0·86	29·19	0·85	1
2	26·59	1·76	27·46	1·74	28·32	1·72	29·17	1·71	2
3	26·57	2·64	27·44	2·61	28·30	2·59	29·15	2·56	3
4	26·54	3·51	27·41	3·48	28·27	3·45	29·12	3·41	4
5	26·50	4·39	27·37	4·35	28·23	4·31	29·08	4·26	5
6	26·46	5·26	27·32	5·22	28·18	5·16	29·03	5·11	6
7	26·41	6·14	27·27	6·08	28·13	6·02	28·97	5·96	7
8	26·34	7·01	27·21	6·94	28·06	6·88	28·91	6·81	8
9	26·28	7·88	27·14	7·80	27·99	7·73	28·83	7·65	9
10	26·20	8·75	27·06	8·66	27·91	8·58	28·75	8·49	10
11	26·11	9·61	26·97	9·52	27·81	9·43	28·65	9·33	11
12	26·02	10·47	26·87	10·37	27·72	10·27	28·55	10·17	12
13	25·92	11·33	26·77	11·22	27·61	11·11	28·44	11·00	13
14	25·81	12·18	26·66	12·07	27·49	11·95	28·32	11·83	14
15	25·70	13·04	26·54	12·91	27·37	12·79	28·20	12·66	15
16	25·57	13·88	26·41	13·75	27·24	13·62	28·06	13·48	16
17	25·44	14·73	26·27	14·59	27·10	14·44	27·91	14·30	17
18	25·30	15·56	26·13	15·42	26·95	15·27	27·76	15·11	18
19	25·15	16·40	25·98	16·24	26·79	16·09	27·60	15·92	19
20	25·00	17·23	25·82	17·06	26·63	16·90	27·43	16·73	20
21	24·84	18·05	25·65	17·88	26·45	17·70	27·25	17·52	21
22	24·67	18·87	25·47	18·69	26·27	18·51	27·06	18·32	22
23	24·49	19·68	25·29	19·49	26·08	19·30	26·87	19·11	23
24	24·30	20·48	25·10	20·29	25·89	20·09	26·67	19·89	24
25	24·11	21·28	24·90	21·09	25·68	20·88	26·46	20·67	25
26	23·91	22·08	24·69	21·87	25·47	21·66	26·24	21·44	26
27	23·70	22·87	24·48	22·65	25·25	22·43	26·01	22·20	27
28	23·49	23·64	24·26	23·42	25·02	23·19	25·77	22·96	28
29	23·27	24·42	24·03	24·19	24·78	23·95	25·53	23·71	29
30	23·04	25·18	23·79	24·95	24·54	24·70	25·28	24·45	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	46·83		46·39		45·94		45·47		53′
54	47·71		47·27		46·81		46·33		54
55	48·59		48·14		47·67		47·19		55
56	49·47		49·02		48·54		48·05		56
57	50·36	0·88	49·89	0·88	49·40	0·87	48·90	0·86	57
58	51·25		50·77		50·27		49·76		58
59	52·13		51·64		51·13		50·62		59
60	53·01		52·52		52·00		51·46		60
61	53·90		53·39		52·87		52·33		61

TABLE VII.

Moon's Appt. Decl.	Latitude. 32° A.	E.	33° A.	E.	34° A.	E.	35° A.	E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	30·04	0·00	30·87	0·00	31·70	0·00	32·51	0·00	0
1	30·03	0·84	30·87	0·84	31·69	0·83	32·51	0·82	1
2	30·02	1·69	30·85	1·67	31·68	1·65	32·49	1·63	2
3	29·99	2·53	30·83	2·50	31·65	2·48	32·47	2·45	3
4	29·96	3·38	30·80	3·34	31·62	3·30	32·44	3·26	4
5	29·92	4·22	30·75	4·17	31·58	4·12	32·39	4·07	5
6	29·87	5·06	30·70	5·00	31·52	4·94	32·34	4·89	6
7	29·81	5·90	30·64	5·83	31·46	5·76	32·27	5·70	7
8	29·74	6·73	30·57	6·66	31·39	6·58	32·20	6·51	8
9	29·67	7·57	30·49	7·49	31·31	7·40	32·11	7·31	9
10	29·58	8·40	30·40	8·31	31·22	8·21	32·02	8·12	10
11	29·48	9·23	30·30	9·13	31·12	9·03	31·92	8·92	11
12	29·38	10·06	30·20	9·95	31·00	9·84	31·80	9·72	12
13	29·27	10·88	30·08	10·76	30·89	10·64	31·68	10·51	13
14	29·14	11·71	29·95	11·58	30·76	11·44	31·55	11·31	14
15	29·01	12·52	29·82	12·38	30·62	12·24	31·41	12·10	15
16	28·87	13·34	29·67	13·19	30·47	13·04	31·26	12·88	16
17	28·72	14·15	29·52	13·99	30·31	13·83	31·09	13·67	17
18	28·56	14·95	29·36	14·79	30·15	14·62	30·92	14·44	18
19	28·40	15·75	29·19	15·58	29·97	15·40	30·74	15·22	19
20	28·22	16·55	29·01	16·37	29·79	16·18	30·55	15·99	20
21	28·04	17·34	28·82	17·15	29·59	16·95	30·35	16·75	21
22	27·85	18·12	28·62	17·93	29·39	17·72	30·15	17·51	22
23	27·65	18·90	28·42	18·70	29·18	18·48	29·93	18·26	23
24	27·44	19·68	28·20	19·46	28·96	19·24	29·70	19·01	24
25	27·22	20·45	27·98	20·22	28·73	19·99	29·47	19·75	25
26	27·00	21·21	27·75	20·98	28·49	20·74	29·22	20·49	26
27	26·76	21·97	27·51	21·72	28·24	21·48	28·97	21·22	27
28	26·52	22·71	27·26	22·46	27·99	22·21	28·71	21·94	28
29	26·27	23·46	27·00	23·20	27·72	22·93	28·44	22·66	29
30	26·01	24·19	26·74	23·93	27·45	23·65	28·16	23·37	30
Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	44·99		44·49		43·98		43·46		53′
54	45·84		45·33		44·81		44·28		54
55	46·69		46·17		45·64		45·10		55
56	47·54		47·01		46·47		45·92		56
57	48·38	0·85	47·85	0·84	47·30	0·83	46·74	0·82	57
58	49·23		48·69		48·13		47·56		58
59	50·08		49·53		48·96		48·38		59
60	50·93		50·37		49·79		49·20		60
61	51·78		51·21		50·62		50·02		61

Moon's Appt. Decl.	Latitude. 36° A.	36° E.	37° A.	37° E.	38° A.	38° E.	39° A.	39° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	33·32	0·00	34·12	0·00	34·91	0·00	35·68	0·00	0
1	33·32	0·81	34·11	0·80	34·90	0·78	35·68	0·77	1
2	33·30	1·61	34·10	1·59	34·88	1·57	35·66	1·55	2
3	33·28	2·42	34·07	2·39	34·86	2·35	35·63	2·32	3
4	33·24	3·22	34·04	3·18	34·82	3·14	35·60	3·09	4
5	33·20	4·02	33·99	3·97	34·77	3·92	35·55	3·87	5
6	33·14	4·83	33·93	4·76	34·71	4·70	35·49	4·64	6
7	33·07	5·63	33·87	5·55	34·65	5·48	35·42	5·41	7
8	33·00	6·43	33·79	6·34	34·57	6·26	35·34	6·17	8
9	32·91	7·22	33·70	7·13	34·48	7·03	35·24	6·94	9
10	32·82	8·02	33·60	7·91	34·38	7·81	35·14	7·70	10
11	32·71	8·81	33·49	8·70	34·26	8·58	35·03	8·46	11
12	32·59	9·60	33·37	9·48	34·14	9·35	34·90	9·22	12
13	32·47	10·39	33·24	10·25	34·01	10·12	34·77	9·98	13
14	32·33	11·17	33·11	11·03	33·87	10·88	34·62	10·73	14
15	32·19	11·95	32·96	11·80	33·72	11·64	34·47	11·48	15
16	32·03	12·73	32·80	12·56	33·55	12·40	34·30	12·23	16
17	31·87	13·50	32·63	13·33	33·38	13·15	34·12	12·97	17
18	31·69	14·27	32·45	14·08	33·20	13·90	33·94	13·71	18
19	31·51	15·03	32·26	14·84	33·00	14·64	33·74	14·44	19
20	31·31	15·79	32·06	15·59	32·80	15·38	33·53	15·17	20
21	31·11	16·54	31·85	16·33	32·59	16·12	33·31	15·90	21
22	30·90	17·33	31·64	17·07	32·36	16·85	33·08	16·62	22
23	30·67	18·04	31·41	17·81	32·13	17·57	32·85	17·33	23
24	30·44	18·78	31·17	18·54	31·89	18·29	32·60	18·04	24
25	30·20	19·51	30·92	19·26	31·64	19·01	32·34	18·75	25
26	29·95	20·24	30·67	19·98	31·37	19·71	32·07	19·44	26
27	29·69	20·96	30·40	20·69	31·10	20·42	31·79	20·14	27
28	29·42	21·67	30·13	21·40	30·82	21·11	31·51	20·82	28
29	29·14	22·38	29·84	22·10	30·53	21·80	31·21	21·50	29
30	28·86	23·08	29·55	22·79	30·23	22·49	30·90	22·18	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	42·93		42·38		41·82		41·24		53′
54	43·74		43·18		42·61		42·02		54
55	44·55		43·98		43·40		42·80		55
56	45·36		44·78		44·19		43·58		56
57	46·17	0·81	45·58	0·80	44·97	0·79	44·36	0·78	57
58	46·98		46·38		45·76		45·14		58
59	47·79		47·18		46·55		45·92		59
60	48·60		47·98		47·34		46·70		60
61	49·41		48·77		48·13		47·47		61

Moon's Appt. Decl.	Latitude. 40°		41°		42°		43°		Moon's Appt. Decl.
	A.	E.	A.	E.	A.	E.	A.	E.	
0°	36′·45	0′·00	37′·20	0′·00	37′·95	0′·00	38′·68	0′·00	0°
1	36·44	0·76	37·20	0·75	37·94	0·74	38·67	0·73	1
2	36·43	1·53	37·18	1·50	37·92	1·48	38·66	1·46	2
3	36·40	2·29	37·15	2·25	37·89	2·22	38·63	2·19	3
4	36·36	3·05	37·11	3·00	37·85	2·96	38·58	2·91	4
5	36·31	3·81	37·06	3·75	37·80	3·70	38·53	3·64	5
6	36·25	4·57	37·00	4·50	37·74	4·43	38·47	4·36	6
7	36·18	5·33	36·93	5·25	37·66	5·17	38·39	5·09	7
8	36·09	6·09	36·84	6·00	37·58	5·90	38·30	5·81	8
9	36·00	6·84	36·74	6·74	37·48	6·64	38·20	6·53	9
10	35·89	7·59	36·64	7·48	37·37	7·37	38·09	7·25	10
11	35·78	8·34	36·52	8·22	37·25	8·09	37·97	7·97	11
12	35·65	9·09	36·39	8·96	37·12	8·82	37·83	8·68	12
13	35·51	9·84	36·25	9·69	36·97	9·54	37·69	9·39	13
14	35·37	10·58	36·10	10·42	36·82	10·26	37·53	10·10	14
15	35·21	11·32	35·94	11·15	36·65	10·98	37·36	10·81	15
16	35·04	12·05	35·76	11·87	36·48	11·69	37·18	11·51	16
17	34·85	12·78	35·58	12·60	36·29	12·40	36·99	12·21	17
18	34·66	13·51	35·38	13·31	36·09	13·11	36·79	12·90	18
19	34·46	14·24	35·18	14·03	35·88	13·81	36·57	13·59	19
20	34·25	14·95	34·96	14·73	35·66	14·51	36·35	14·28	20
21	34·03	15·67	34·73	15·44	35·43	15·20	36·11	14·96	21
22	33·79	16·38	34·49	16·14	35·18	15·89	35·86	15·64	22
23	33·55	17·08	34·25	16·83	34·93	16·58	35·60	16·31	23
24	33·30	17·79	33·99	17·52	34·66	17·25	35·33	16·98	24
25	33·03	18·48	33·72	18·21	34·39	17·93	35·05	17·64	25
26	32·76	19·17	33·44	18·88	34·11	18·60	34·76	18·30	26
27	32·48	19·85	33·15	19·56	33·81	19·26	34·46	18·95	27
28	32·18	20·53	32·85	20·22	33·50	19·92	34·15	19·60	28
29	31·88	21·20	32·54	20·89	33·19	20·57	33·83	20·24	29
30	31·57	21·86	32·22	21·54	32·86	21·21	33·49	20·88	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	40·66		40·06		39·44		38·82		53′
54	41·43		40·82		40·19		39·55		54
55	42·20		41·57		40·93		40·28		55
56	43·96		42·33		41·68		41·02		56
57	43·72	0·77	43·08	0·76	42·42	0·75	41·75	0·73	57
58	44·49		43·84		43·17		42·48		58
59	45·25		44·59		43·91		43·21		59
60	46·02		45·35		44·66		43·95		60
61	46·79		46·10		45·40		44·68		61

Moon's Appt. Decl.	Latitude. 44°		45°		46°		47°		Moon's Appt. Decl.
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	39.40	0.00	40.11	0.00	40.80	0.00	41.49	0.00	0
1	39.39	0.72	40.10	0.70	40.80	0.69	41.48	0.68	1
2	39.38	1.43	40.08	1.41	40.78	1.38	41.46	1.36	2
3	39.34	2.15	40.05	2.11	40.75	2.08	41.43	2.04	3
4	39.30	2.86	40.01	2.82	40.70	2.77	41.39	2.72	4
5	39.25	3.58	39.95	3.52	40.65	3.46	41.33	3.39	5
6	39.18	4.29	39.89	4.22	40.58	4.15	41.26	4.07	6
7	39.10	5.00	39.81	4.92	40.50	4.83	41.18	4.75	7
8	39.02	5.72	39.72	5.62	40.41	5.52	41.08	5.42	8
9	38.91	6.42	39.61	6.32	40.30	6.20	40.98	6.09	9
10	38.80	7.13	39.50	7.01	40.18	6.89	40.86	6.76	10
11	38.67	7.84	39.37	7.70	40.05	7.57	40.72	7.43	11
12	38.54	8.54	39.23	8.39	39.91	8.25	40.58	8.10	12
13	38.39	9.24	39.08	9.08	39.76	8.92	40.42	8.76	13
14	38.23	9.94	38.92	9.77	39.59	9.60	40.25	9.42	14
15	38.06	10.63	38.74	10.45	39.41	10.27	40.07	10.08	15
16	37.87	11.32	38.55	11.13	39.22	10.93	39.88	10.73	16
17	37.68	12.01	38.35	11.80	39.02	11.60	39.67	11.62	17
18	37.47	12.69	38.14	12.48	38.81	12.26	39.46	12.03	18
19	37.25	13.37	37.92	13.14	38.58	12.91	39.23	12.68	19
20	37.02	14.05	37.69	13.81	38.34	13.57	38.98	13.32	20
21	36.78	14.72	37.44	14.47	38.09	14.21	38.73	13.96	21
22	36.53	15.38	37.19	15.12	37.83	14.86	38.47	14.59	22
23	36.27	16.05	36.92	15.77	37.56	15.50	38.19	15.22	23
24	35.99	16.70	36.64	16.42	37.28	16.13	37.90	15.84	24
25	35.71	17.36	36.35	17.06	36.98	16.76	37.60	16.46	25
26	35.41	18.00	36.05	17.70	36.67	17.39	37.29	17.07	26
27	35.10	18.64	35.74	18.33	36.36	18.01	36.97	17.68	27
28	34.79	19.28	35.41	18.95	36.03	18.62	36.63	18.28	28
29	34.46	19.91	35.08	19.57	35.69	19.23	36.29	18.88	29
30	34.12	20.53	34.73	20.19	35.34	19.83	35.93	19.47	30
Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	38.18		37.54		36.88		36.21		53′
54	38.90		38.25		37.57		36.89		54
55	39.62		38.96		38.27		37.57		55
56	40.34		39.67		38.96		38.25		56
57	41.07	0.72	40.37	0.71	39.66	0.70	38.94	0.68	57
58	41.79		41.08		40.35		39.62		58
59	42.51		41.79		41.05		40.30		59
60	43.23		42.50		41.75		40.98		60
61	43.95		43.20		42.45		41.67		61

Moon's Appt. Decl.	Latitude. 48° A.	48° E.	49° A.	49° E.	50° A.	50° E.	51° A.	51° E.	Moon's Appt. Decl.
0°	42′·16	0′·00	42′·82	0′·00	43′·46	0′·00	44′·09	0′·00	0°
1	42·15	0·67	42·81	0·65	43·46	0·64	44·09	0·63	1
2	42·13	1·33	42·79	1·31	43·44	1·28	44·07	1·25	2
3	42·10	2·00	42·76	1·96	43·40	1·92	44·03	1·88	3
4	42·06	2·66	42·71	2·61	43·36	2·56	43·99	2·51	4
5	42·00	3·33	42·65	3·27	43·30	3·20	43·93	3·13	5
6	41·93	3·99	42·58	3·92	43·22	3·84	43·85	3·76	6
7	41·85	4·66	42·50	4·57	43·14	4·47	43·77	4·38	7
8	41·75	5·32	42·40	5·21	43·04	5·11	43·66	5·00	8
9	41·64	5·98	42·29	5·86	42·93	5·74	43·55	5·62	9
10	41·52	6·63	42·17	6·51	42·80	6·37	43·42	6·24	10
11	41·39	7·29	42·03	7·15	42·66	7·00	43·28	6·86	11
12	41·24	7·94	41·88	7·79	42·51	7·63	43·13	7·47	12
13	41·08	8·59	41·72	8·43	42·35	8·26	42·96	8·09	13
14	40·91	9·24	41·54	9·06	42·17	8·88	42·78	8·70	14
15	40·72	9·89	41·36	9·70	41·98	9·50	42·59	9·30	15
16	40·53	10·53	41·16	10·33	41·78	10·12	42·39	9·91	16
17	40·32	11·17	40·95	10·95	41·56	10·73	42·17	10·51	17
18	40·10	11·81	40·72	11·58	41·34	11·34	41·94	11·11	18
19	39·86	12·44	40·48	12·20	41·09	11·95	41·69	11·70	19
20	39·62	13·07	40·23	12·81	40·84	12·56	41·43	12·29	20
21	39·36	13·69	39·97	13·43	40·58	13·75	41·17	12·88	21
22	39·09	14·31	39·70	14·03	40·30	13·15	40·88	13·46	22
23	38·81	14·93	39·41	14·64	40·01	14·34	40·59	14·04	23
24	38·52	15·54	39·12	15·24	39·70	14·93	40·28	14·62	24
25	38·21	16·15	38·81	15·83	39·39	15·51	39·96	15·19	25
26	37·89	16·75	38·40	16·42	39·06	16·09	39·63	15·76	26
27	37·56	17·35	38·15	17·01	38·73	16·67	39·29	16·32	27
28	37·23	17·94	37·80	17·59	38·37	17·23	38·93	16·87	28
29	36·87	18·52	37·45	18·16	38·01	17·80	38·57	17·43	29
30	36·51	19·10	37·08	18·73	37·64	18·35	38·19	17·97	30

Moon's H. P.	48° I.	Diff.	49° I.	Diff.	50° I.	Diff.	51° I.	Diff.	Moon's H. P.
53′	35·53		34·84		34·13		33·42		53′
54	36·20		35·49		34·77		34·05		54
55	36·87		36·15		35·42		34·68		55
56	37·54		36·81		36·06		35·31		56
57	38·21	0·67	37·47	0·66	36·71	0·65	35·94	0·63	57
58	38·88		38·12		37·35		36·57		58
59	39·55		38·78		38·00		37·20		59
60	40·22		39·43		38·64		37·83		60
61	40·89		40·09		39·29		38·46		61

Moon's Appt. Decl.	Latitude.								Moon's Appt. Decl.
	52°		53°		54°		55°		
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	44·71	0·00	45·32	0·00	45·91	0·00	46·49	0·00	0
1	44·71	0·61	45·31	0·60	45·90	0·59	46·48	0·57	1
2	44·69	1·23	45·29	1·20	45·88	1·17	46·46	1·14	2
3	44·65	1·84	45·26	1·80	45·85	1·76	46·42	1·71	3
4	44·60	2·45	45·21	2·40	45·80	2·34	46·37	2·29	4
5	44·54	3·06	45·15	3·00	45·74	2·93	46·31	2·86	5
6	44·47	3·68	45·07	3·59	45·66	3·51	46·23	3·42	6
7	44·38	4·29	44·98	4·19	45·57	4·09	46·14	3·99	7
8	44·28	4·89	44·88	4·78	45·46	4·67	46·04	4·56	8
9	44·16	5·50	44·76	5·38	45·35	5·25	45·92	5·13	9
10	44·03	6·11	44·63	5·97	45·21	5·83	45·78	5·69	10
11	43·89	6·71	44·49	6·56	45·07	6·41	45·63	6·25	11
12	43·74	7·31	44·33	7·15	44·91	6·98	45·47	6·81	12
13	43·57	7·91	44·16	7·73	44·73	7·55	45·30	7·37	13
14	43·39	8·51	43·97	8·32	44·55	8·12	45·11	7·93	14
15	43·19	9·10	43·77	8·90	44·35	8·69	44·90	8·48	15
16	42·98	9·69	43·56	9·48	44·13	9·25	44·69	9·03	16
17	42·76	10·28	43·34	10·05	43·90	9·82	44·46	9·58	17
18	42·53	10·87	43·10	10·62	43·66	10·38	44·21	10·13	18
19	42·28	11·45	42·85	11·19	43·41	10·93	43·96	10·67	19
20	42·02	12·03	42·59	11·76	43·14	11·49	43·68	11·21	20
21	41·74	12·60	42·31	12·32	42·86	12·03	43·40	11·74	21
22	41·46	13·17	42·02	12·88	42·57	12·58	43·10	12·27	22
23	41·16	13·74	41·72	13·43	42·26	13·12	42·79	12·80	23
24	40·85	14·30	41·40	13·98	41·94	13·66	42·47	13·33	24
25	40·52	14·86	41·07	14·53	41·61	14·19	42·13	13·85	25
26	40·19	15·41	40·73	15·07	41·26	14·72	41·78	14·36	26
27	39·84	15·96	40·38	15·61	40·91	15·24	41·42	14·88	27
28	39·48	16·51	40·01	16·14	40·54	15·76	41·05	15·38	28
29	39·11	17·05	39·64	16·67	40·15	16·28	40·66	15·89	29
30	38·72	17·58	39·25	17·19	39·76	16·79	40·26	16·38	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	32·70		31·96		31·22		30·47		53′
54	33·32		32·56		31·81		31·04		54
55	33·93		33·17		32·40		31·62		55
56	34·55		33·77		32·99		32·19		56
57	35·16	0·62	34·38	0·60	33·58	0·59	32·77	0·58	57
58	35·78		34·98		34·17		33·34		58
59	36·39		35·59		34·76		33·92		59
60	37·01		36·19		35·35		34·49		60
61	37·63		36·79		35·93		35·07		61

Moon's Appt. Decl.	Latitude. 56° A.	56° E.	57° A.	57° E.	58° A.	58° E.	59° A.	59° E.	Moon's Appt. Decl.
0°	47·05′	0·00′	47·60′	0·00′	48·14′	0·00′	48·66′	0·00′	0°
1	47·04	0·56	47·59	0·54	48·13	0·53	48·65	0·51	1
2	47·02	1·11	47·57	1·09	48·11	1·06	48·63	1·03	2
3	46·99	1·67	47·54	1·63	48·07	1·58	48·59	1·54	3
4	46·94	2·23	47·49	2·17	48·02	2·11	48·54	2·05	4
5	46·87	2·78	47·42	2·71	47·95	2·64	48·47	2·56	5
6	46·79	3·34	47·34	3·25	47·87	3·17	48·39	3·08	6
7	46·70	3·89	47·25	3·77	47·78	3·69	48·29	3·59	7
8	46·59	4·45	47·14	4·33	47·67	4·21	48·18	4·10	8
9	46·47	5·00	47·01	4·87	47·54	4·74	48·06	4·60	9
10	46·34	5·55	46·88	5·40	47·40	5·26	47·92	5·11	10
11	46·19	6·10	46·73	5·94	47·25	5·78	47·76	5·62	11
12	46·02	6·64	46·56	6·47	47·08	6·29	47·59	6·12	12
13	45·85	7·19	46·38	7·00	46·90	6·81	47·41	6·62	13
14	45·65	7·73	46·19	7·53	46·71	7·32	47·21	7·12	14
15	45·45	8·27	45·98	8·05	46·50	7·84	47·00	7·62	15
16	45·23	8·81	45·76	8·58	46·27	8·35	46·77	8·11	16
17	45·00	9·34	45·52	9·10	46·03	8·85	46·53	8·60	17
18	44·75	9·87	45·27	9·62	45·78	9·36	46·27	9·09	18
19	44·49	10·40	45·01	10·13	45·51	9·86	46·01	9·58	19
20	44·21	10·93	44·73	10·64	45·23	10·36	45·72	10·07	20
21	43·93	11·45	44·44	11·15	44·94	10·85	45·42	10·55	21
22	43·63	11·97	44·14	11·66	44·63	11·34	45·11	11·02	22
23	43·31	12·48	43·82	12·16	44·31	11·83	44·79	11·50	23
24	42·98	12·99	43·49	12·66	43·97	12·31	44·45	11·97	24
25	42·64	13·50	43·14	13·15	43·63	12·80	44·10	12·44	25
26	42·29	14·00	42·78	13·64	43·26	13·27	43·73	12·90	26
27	41·92	14·50	42·41	14·13	42·89	13·75	43·35	13·36	27
28	41·54	15·00	42·03	14·61	42·50	14·21	42·96	13·82	28
29	41·15	15·49	41·63	15·09	42·10	14·68	42·56	14·27	29
30	40·75	15·97	41·22	15·56	41·69	15·14	42·14	14·71	30

Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	29·70		28·93		28·15		27·36		53′
54	30·26		29·48		28·68		27·88		54
55	30·82		30·03		29·21		28·40		55
56	31·38		30·58		29·74		28·92		56
57	31·94	0·56	31·12	0·55	30·28	0·53	29·43	0·52	57
58	32·50		31·67		30·81		29·95		58
59	33·06		32·22		31·34		30·46		59
60	33·62		32·76		31·87		30·98		60
61	34·17		33·30		32·40		31·49		61

Moon's Appt. Decl.	Latitude. 60°		61°		62°		63°		Moon's Appt. Decl.
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	49·16	0·00	49·65	0·00	50·13	0·00	50·59	0·00	0
1	49·15	0·50	49·64	0·48	50·12	0·47	50·58	0·45	1
2	49·13	1·00	49·62	0·97	50·10	0·94	50·56	0·91	2
3	49·09	1·50	49·58	1·45	50·06	1·40	50·52	1·36	3
4	49·04	1·99	49·53	1·93	50·00	1·87	50·46	1·81	4
5	48·97	2·49	49·46	2·41	49·94	2·34	50·39	2·26	5
6	48·89	2·99	49·38	2·90	49·85	2·80	50·31	2·71	6
7	48·79	3·48	49·28	3·38	49·75	3·27	50·21	3·16	7
8	48·68	3·98	49·17	3·86	49·64	3·73	50·09	3·61	8
9	48·56	4·47	49·04	4·33	49·51	4·20	49·96	4·06	9
10	48·41	4·96	48·90	4·81	49·37	4·66	49·82	4·51	10
11	48·26	5·45	48·74	5·29	49·21	5·12	49·66	4·95	11
12	48·09	5·94	48·57	5·76	49·03	5·58	49·48	5·39	12
13	47·90	6·43	48·38	6·23	48·84	6·03	49·29	5·84	13
14	47·70	6·91	48·18	6·70	48·64	6·49	49·08	6·28	14
15	47·49	7·39	47·96	7·17	48·42	6·94	48·86	6·72	15
16	47·26	7·87	47·73	7·64	48·18	7·39	48·63	7·15	16
17	47·01	8·35	47·48	8·10	47·94	7·84	48·38	7·59	17
18	46·75	8·83	47·22	8·56	47·67	8·29	48·11	8·02	18
19	46·48	9·30	46·95	9·02	47·40	8·73	47·83	8·45	19
20	46·20	9·77	46·66	9·48	47·10	9·18	47·54	8·87	20
21	45·90	10·24	46·35	9·93	46·80	9·61	47·23	9·30	21
22	45·58	10·70	46·04	10·38	46·48	10·05	46·90	9·72	22
23	45·25	11·16	45·70	10·82	46·14	10·48	46·56	10·14	23
24	44·91	11·62	45·36	11·27	45·79	10·91	46·21	10·55	24
25	44·56	12·07	45·00	11·71	45·43	11·34	45·85	10·96	25
26	44·19	12·52	44·63	12·14	45·05	11·76	45·47	11·37	26
27	43·80	12·97	44·24	12·58	44·66	12·18	45·07	11·78	27
28	43·41	13·41	43·84	13·01	44·26	12·60	44·67	12·18	28
29	43·00	13·85	43·43	13·43	43·84	13·01	44·24	12·58	29
30	42·57	14·28	43·00	13·85	43·41	13·41	43·81	12·97	30
Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	26·57		25·76		24·95		24·12		53′
54	27·07		26·25		25·42		24·57		54
55	27·57		26·73		25·89		25·03		55
56	28·07		27·21		26·36		25·48		56
57	28·57	0·50	27·70	0·49	26·83	0·47	25·94	0·46	57
58	29·07		28·19		27·30		26·39		58
59	29·57		28·67		27·77		26·85		59
60	30·07		29·16		28·24		27·31		60
61	30·57		29·65		28·71		27·77		61

Moon's Appt. Decl.	Latitude. 64° A.	64° E.	65° A.	65° E.	66° A.	66° E.	67° A.	67° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	51·03	0·00	51·46	0·00	51·87	0·00	52·27	0·00	0
1	51·02	0·44	51·45	0·42	51·87	0·41	52·26	0·39	1
2	51·00	0·87	51·43	0·84	51·84	0·81	52·24	0·78	2
3	50·96	1·31	51·39	1·26	51·80	1·22	52·20	1·17	3
4	50·91	1·75	51·33	1·69	51·75	1·62	52·14	1·56	4
5	50·84	2·18	51·26	2·11	51·68	2·03	52·07	1·95	5
6	50·75	2·62	51·18	2·52	51·59	2·43	51·98	2·33	6
7	50·65	3·05	51·08	2·94	51·49	2·83	51·88	2·72	7
8	50·53	3·49	50·96	3·36	51·37	3·24	51·76	3·11	8
9	50·40	3·92	50·83	3·78	51·23	3·64	51·63	3·49	9
10	50·26	4·35	50·68	4·19	51·09	4·04	51·48	3·88	10
11	50·09	4·78	50·51	4·61	50·92	4·44	51·31	4·26	11
12	49·92	5·21	50·34	5·02	50·74	4·83	51·13	4·64	12
13	49·72	5·64	50·14	5·43	50·54	5·23	50·93	5·02	13
14	49·52	6·06	49·93	5·84	50·33	5·62	50·72	5·40	14
15	49·29	6·48	49·71	6·25	50·11	6·02	50·49	5·78	15
16	49·05	6·91	49·47	6·66	49·86	6·41	50·25	6·16	16
17	48·80	7·32	49·21	7·06	49·61	6·80	49·99	6·53	17
18	48·53	7·74	48·94	7·46	49·33	7·18	49·71	6·90	18
19	48·25	8·16	48·66	7·86	49·05	7·57	49·42	7·27	19
20	47·95	8·57	48·36	8·26	48·74	7·95	49·12	7·64	20
21	47·64	8·98	48·04	8·66	48·43	8·33	48·80	8·00	21
22	47·32	9·39	47·71	9·05	48·10	8·71	48·46	8·37	22
23	46·97	9·79	47·37	9·44	47·75	9·08	48·12	8·73	23
24	46·62	10·19	47·01	9·82	47·39	9·46	47·75	9·08	24
25	46·25	10·59	46·64	10·21	47·01	9·82	47·37	9·44	25
26	45·87	10·98	46·25	10·59	46·62	10·19	46·98	9·79	26
27	45·47	11·37	45·85	10·97	46·22	10·55	46·57	10·14	27
28	45·06	11·76	45·44	11·34	45·80	10·91	46·15	10·48	28
29	44·63	12·15	45·01	11·71	45·37	11·27	45·72	10·83	29
30	44·19	12·53	44·57	12·08	44·92	11·62	45·27	11·17	30
Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	23·30		22·46		21·62		20·77		53′
54	23·74		22·88		22·03		21·16		54
55	24·18		23·30		22·44		21·55		55
56	24·62		23·72		22·85		21·94		56
57	25·06	0·44	24·15	0·42	23·25	0·41	22·34	0·39	57
58	25·49		24·57		23·66		22·73		58
59	25·93		24·99		24·07		23·12		59
60	26·37		25·42		24·48		23·51		60
61	26·81		25·85		24·88		23·90		61

Moon's Appt. Decl.	Latitude. 68° A.	68° E.	69° A.	69° E.	70° A.	70° E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	°
0	52·65	0·00	53·02	0·00	53·37	0·00	0
1	52·64	0·37	53·01	0·36	53·36	0·34	1
2	52·62	0·75	52·99	0·71	53·33	0·68	2
3	52·58	1·12	52·94	1·07	53·29	1·02	3
4	52·52	1·49	52·89	1·43	53·24	1·36	4
5	52·45	1·87	52·82	1·79	53·16	1·70	5
6	52·36	2·24	52·73	2·14	53·07	2·04	6
7	52·26	2·61	52·62	2·50	52·97	2·38	7
8	52·14	2·98	52·50	2·85	52·85	2·72	8
9	52·00	3·35	52·36	3·20	52·71	3·06	9
10	51·85	3·72	52·21	3·56	52·56	3·40	10
11	51·68	4·09	52·04	3·91	52·39	3·73	11
12	51·50	4·45	51·86	4·26	52·20	4·06	12
13	51·30	4·82	51·66	4·61	52·00	4·40	13
14	51·09	5·18	51·44	4·96	51·78	4·73	14
15	50·86	5·54	51·21	5·30	51·55	5·06	15
16	50·61	5·90	50·96	5·65	51·30	5·39	16
17	50·35	6·26	50·70	5·99	51·03	5·72	17
18	50·07	6·62	50·42	6·33	50·75	6·04	18
19	49·78	6·97	50·13	6·67	50·46	6·37	19
20	49·48	7·32	49·82	7·01	50·15	6·69	20
21	49·15	7·67	49·50	7·34	49·82	7·01	21
22	48·82	8·02	49·16	7·67	49·48	7·32	22
23	48·47	8·37	48·80	8·00	49·12	7·64	23
24	48·10	8·71	48·43	8·33	48·75	7·95	24
25	47·72	9·05	48·05	8·66	48·37	8·26	25
26	47·32	9·39	47·65	8·98	47·97	8·57	26
27	46·91	9·72	47·24	9·30	47·55	8·88	27
28	46·49	10·05	46·81	9·62	47·12	9·18	28
29	46·05	10·38	46·37	9·93	46·68	9·48	29
30	45·60	10·71	45·91	10·24	46·21	9·78	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	19·91		19·05		18·18		53′
54	20·29		19·41		18·52		54
55	20·66		19·77		18·86		55
56	21·03		20·13		19·20		56
57	21·41	0·38	20·49	0·36	19·55	0·34	57
58	21·79		20·85		19·89		58
59	22·17		21·21		20·23		59
60	22·55		21·57		20·57		60
61	22·92		21·92		20·92		61

AUXILIARY TABLE,

Factor p,

***for correcting* A *and* E.**

Moon's H.P.	*p*
53′·0	0·93
53·5	0·94
54·0	0·95
54·5	0·96
55·0	0·96
55·5	0·97
56·0	0·98
56·5	0·99
57·0	1·00
57·5	1·01
58·0	1·02
58·5	1·03
59·0	1·04
59·5	1·04
60·0	1·05
60·5	1·06
61·0	1·07

Moon's Appt. Decl.	Singapore. 1° 16′·2 N. A.	Singapore. E.	Pulo Penang. 5° 25′·0 N. A.	Pulo Penang. E.	Batavia. 6° 8′·9 S. A.	Batavia. E.	Ascension. 7° 55′·5 S. A.	Ascension. E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	1·26	0·00	5·35	0·00	6·06	0·00	7·81	0·00	0
1	1·25	0·99	5·34	0·99	6·06	0·99	7·81	0·99	1
2	1·25	1·99	5·34	1·98	6·06	1·98	7·80	1·97	2
3	1·25	2·98	5·34	2·97	6·06	2·97	7·80	2·95	3
4	1·25	3·98	5·33	3·96	6·05	3·95	7·79	3·94	4
5	1·25	4·97	5·33	4·95	6·04	4·94	7·78	4·92	5
6	1·25	5·96	5·32	5·93	6·03	5·92	7·77	5·90	6
7	1·25	6·94	5·31	6·92	6·02	6·91	7·75	6·88	7
8	1·24	7·93	5·29	7·90	6·01	7·89	7·73	7·86	8
9	1·24	8·91	5·28	8·88	5·99	8·87	7·71	8·83	9
10	1·24	9·90	5·26	9·85	5·97	9·84	7·69	9·80	10
11	1·23	10·87	5·25	10·83	5·95	10·81	7·66	10·77	11
12	1·23	11·85	5·23	11·80	5·93	11·78	7·64	11·74	12
13	1·22	12·82	5·21	12·77	5·91	12·75	7·61	12·70	13
14	1·22	13·79	5·19	13·73	5·88	13·71	7·58	13·66	14
15	1·21	14·75	5·16	14·69	5·86	14·67	7·54	14·61	15
16	1·21	15·71	5·14	15·64	5·83	15·62	7·51	15·56	16
17	1·20	16·66	5·11	16·59	5·80	16·57	7·47	16·51	17
18	1·19	17·61	5·08	17·54	5·77	17·51	7·43	17·45	18
19	1·19	18·55	5·05	18·47	5·73	18·45	7·38	18·38	19
20	1·18	19·49	5·02	19·41	5·70	19·38	7·34	19·31	20
21	1·17	20·42	4·99	20·34	5·66	20·31	7·29	20·23	21
22	1·16	21·35	4·96	21·26	5·62	21·23	7·24	21·15	22
23	1·16	22·27	4·92	22·17	5·58	22·14	7·19	22·06	23
24	1·15	23·18	4·88	23·08	5·54	23·05	7·13	22·96	24
25	1·14	24·08	4·84	23·98	5·50	23·95	7·08	23·86	25
26	1·13	24·98	4·80	24·88	5·45	24·84	7·02	24·75	26
27	1·12	25·87	4·76	25·76	5·40	25·73	6·96	25·63	27
28	1·11	26·75	4·72	26·64	5·36	26·61	6·89	26·51	28
29	1·10	27·63	4·68	27·51	5·30	27·48	6·83	27·37	29
30	1·09	28·49	4·63	28·37	5·25	28·34	6·76	28·23	30

Moon's H.P.	Singapore I.	Diff.	Pulo Penang I.	Diff.	Batavia I.	Diff.	Ascension I.	Diff.	Moon's H.P.
53′	52·99		52·76		52·70		52·50		53′
54	53·99		53·76		53·69		53·49		54
55	54·99		54·76		54·69		54·48		55
56	55·99		55·75		55·68		55·47		56
57	56·99	1·00	56·75	1·00	56·67	0·99	56·46	0·99	57
58	57·99		57·75		57·67		57·45		58
59	58·99		58·74		58·66		58·44		59
60	59·99		59·74		59·66		59·43		60
61	60·99		60·73		60·65		60·42		61

Moon's Appt. Decl.	Trincomalee. 8° 33′·5 N. A.	Trincomalee. E.	Callao. 12° 4′·0 S. A.	Callao. E.	Madras. 13° 4′·1 N. A.	Madras. E.	Martinique. 14° 35′·9 N. A.	Martinique. E.	Moon's Appt. Decl.
0°	8′·43	0′·00	11′·84	0′·00	12′·81	0′·00	14′·28	0′·00	0°
1	8·43	0·98	11·84	0·97	12·80	0·97	14·27	0·96	1
2	8·42	1·97	11·83	1·95	12·80	1·94	14·27	1·93	2
3	8·42	2·95	11·82	2·92	12·79	2·91	14·26	2·89	3
4	8·41	3·93	11·81	3·89	12·78	3·87	14·24	3·85	4
5	8·40	4·91	11·79	4·86	12·76	4·84	14·22	4·81	5
6	8·38	5·89	11·77	5·83	12·74	5·80	14·20	5·77	6
7	8·36	6·87	11·75	6·79	12·71	6·77	14·17	6·72	7
8	8·35	7·84	11·72	7·76	12·68	7·73	14·14	7·68	8
9	8·32	8·82	11·69	8·72	12·65	8·69	14·10	8·63	9
10	8·30	9·79	11·66	9·68	12·61	9·64	14·06	9·58	10
11	8·27	10·76	11·62	10·64	12·57	10·60	14·01	10·53	11
12	8·24	11·72	11·58	11·59	12·53	11·55	13·96	11·47	12
13	8·21	12·68	11·54	12·54	12·48	12·49	13·91	12·41	13
14	8·18	13·64	11·49	13·49	12·43	13·43	13·85	13·35	14
15	8·14	14·59	11·44	14·43	12·37	14·37	13·79	14·28	15
16	8·10	15·54	11·38	15·37	12·31	15·31	13·72	15·21	16
17	8·06	16·48	11·32	16·30	12·25	16·24	13·65	16·13	17
18	8·02	17·42	11·26	17·23	12·18	17·16	13·58	17·05	18
19	7·97	18·35	11·19	18·15	12·11	18·08	13·50	17·96	19
20	7·92	19·28	11·13	19·07	12·03	18·99	13·41	18·87	20
21	7·87	20·20	11·05	19·98	11·96	19·90	13·33	19·77	21
22	7·81	21·12	10·98	20·88	11·87	20·80	13·24	20·67	22
23	7·76	22·03	10·90	21·78	11·79	21·70	13·14	21·56	23
24	7·70	22·93	10·82	22·67	11·70	22·59	13·04	22·44	24
25	7·64	23·82	10·73	23·56	11·61	23·47	12·94	23·32	25
26	7·57	24·71	10·64	24·44	11·51	24·34	12·83	24·19	26
27	7·51	25·59	10·55	25·31	11·41	25·21	12·72	25·05	27
28	7·44	26·46	10·45	26·17	11·31	26·07	12·60	25·90	28
29	7·37	27·33	10·35	27·03	11·20	26·92	12·49	26·75	29
30	7·30	28·18	10·25	27·87	11·09	27·77	12·36	27·59	30
Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	52·41		51·84		51·64		51·30		53′
54	53·40		52·82		52·61		52·27		54
55	54·39		53·80		53·58		53·24		55
56	55·38		54·78		54·55		54·21		56
57	56·37	0·99	55·75	0·98	55·53	0·97	55·17	0·97	57
58	57·36		56·73		56·50		56·14		58
59	58·35		57·71		57·47		57·11		59
60	59·34		58·69		58·45		58·08		60
61	60·32		59·66		59·43		59·04		61

Table VIII.

Moon's Appt. Decl.	St. Helena. 15° 55′·0 S. A.	E.	Tahiti. 17° 29′·3 S. A.	E.	Port Royal. 17° 56′·1 N. A.	E.	Bombay. 18° 56′·1 N. A.	E.	Moon's Appt. Decl.
0°	15′·54	0′·00	17′·02	0′·00	17′·44	0′·00	18′·38	0′·00	0°
1	15·54	0·96	17·02	0·95	17·44	0·95	18·38	0·94	1
2	15·53	1·91	17·01	1·90	17·43	1·89	18·37	1·88	2
3	15·52	2·87	17·00	2·85	17·42	2·84	18·36	2·82	3
4	15·50	3·82	16·98	3·79	17·40	3·78	18·34	3·76	4
5	15·48	4·78	16·96	4·74	17·38	4·73	18·31	4·70	5
6	15·45	5·73	16·93	5·68	17·35	5·67	18·28	5·64	6
7	15·42	6·68	16·89	6·63	17·31	6·61	18·24	6·57	7
8	15·39	7·63	16·86	7·57	17·27	7·55	18·20	7·51	8
9	15·35	8·58	16·81	8·51	17·23	8·49	18·15	8·44	9
10	15·30	9·52	16·76	9·44	17·18	9·42	18·10	9·37	10
11	15·25	10·46	16·71	10·38	17·12	10·35	18·04	10·29	11
12	15·20	11·40	16·65	11·31	17·06	11·28	17·98	11·21	12
13	15·14	12·33	16·59	12·23	17·00	12·20	17·91	12·13	13
14	15·08	13·26	16·52	13·16	16·92	13·12	17·84	13·05	14
15	15·01	14·19	16·44	14·07	16·85	14·04	17·75	13·96	15
16	14·94	15·11	16·36	14·99	16·77	14·95	17·67	14·87	16
17	14·86	16·03	16·28	15·90	16·68	15·86	17·58	15·77	17
18	14·78	16·94	16·19	16·80	16·59	16·76	17·48	16·67	18
19	14·69	17·85	16·09	17·70	16·49	17·66	17·38	17·56	19
20	14·60	18·75	16·00	18·60	16·39	18·55	17·27	18·45	20
21	14·51	19·65	15·89	19·49	16·28	19·44	17·16	19·33	21
22	14·41	20·54	15·78	20·37	16·17	20·32	17·04	20·20	22
23	14·30	21·42	15·67	21·25	16·06	21·20	16·92	21·07	23
24	14·20	22·30	15·55	22·12	15·94	22·06	16·79	21·94	24
25	14·08	23·17	15·43	22·98	15·81	22·93	16·66	22·79	25
26	13·97	24·03	15·30	23·84	15·68	23·78	16·52	23·64	26
27	13·85	24·89	15·17	24·69	15·54	24·63	16·38	24·49	27
28	13·72	25·74	15·03	25·53	15·40	25·47	16·23	25·32	28
29	13·59	26·58	14·89	26·36	15·26	26·30	16·08	26·15	29
30	13·46	27·41	14·74	27·19	15·11	27·12	15·92	26·97	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	50·98		50·57		50·44		50·15		53′
54	51·94		51·52		51·39		51·09		54
55	52·90		52·47		52·34		52·04		55
56	53·86		53·42		53·29		52·98		56
57	54·83	0·96	54·38	0·95	54·25	0·95	53·93	0·95	57
58	55·79		55·33		55·20		54·88		58
59	56·75		56·29		56·15		55·83		59
60	57·71		57·24		57·10		56·78		60
61	58·67		58·20		58·05		57·72		61

Moon's Appt. Decl.	Vera Cruz. 19° 11′·9 N. A.	Vera Cruz. E.	Mauritius. 20° 9′·4 S. A.	Mauritius. E.	Honoruru (Sandwich Islands) 21° 18′·2 N. A.	Honoruru E.	Hong Kong. 22° 16′·4 N. A.	Hong Kong. E.	Moon's Appt. Decl.
0°	18′·63	0′·00	19′·52	0′·00	20′·58	0′·00	21′·47	0′·00	0°
1	18·62	0·94	19·52	0·93	20·58	0·93	21·47	0·92	1
2	18·62	1·88	19·51	1·87	20·57	1·85	21·46	1·84	2
3	18·60	2·82	19·49	2·80	20·55	2·78	21·44	2·76	3
4	18·58	3·76	19·47	3·73	20·53	3·71	21·42	3·68	4
5	18·56	4·69	19·45	4·67	20·50	4·63	21·39	4·60	5
6	18·53	5·63	19·41	5·60	20·47	5·55	21·36	5·52	6
7	18·49	6·56	19·37	6·52	20·43	6·47	21·31	6·43	7
8	18·45	7·49	19·33	7·62	20·38	7·39	21·26	7·34	8
9	18·40	8·42	19·28	8·37	20·33	8·31	21·21	8·26	9
10	18·34	9·35	19·22	9·30	20·27	9·23	21·15	9·16	10
11	18·29	10·27	19·16	10·21	20·20	10·14	21·08	10·07	11
12	18·22	11·20	19·09	11·13	20·13	11·05	21·00	10·97	12
13	18·15	12·11	19·02	12·04	20·05	11·95	20·92	11·87	13
14	18·07	13·03	18·94	12·95	19·97	12·85	20·83	12·77	14
15	17·99	13·94	18·86	13·85	19·88	13·75	20·74	13·66	15
16	17·91	14·84	18·76	14·75	19·78	14·64	20·64	14·55	16
17	17·81	15·74	18·67	15·65	19·68	15·53	20·53	15·43	17
18	17·72	16·64	18·56	16·54	19·57	16·42	20·42	16·31	18
19	17·61	17·53	18·46	17·43	19·46	17·30	20·30	17·18	19
20	17·50	18·42	18·34	18·31	19·34	18·17	20·18	18·05	20
21	17·39	19·30	18·22	19·18	19·21	19·04	20·05	18·91	21
22	17·27	20·17	18·10	20·05	19·08	19·90	19·91	19·77	22
23	17·15	21·04	17·97	20·92	18·95	20·76	19·77	20·62	23
24	17·02	21·90	17·83	21·77	18·80	21·61	19·62	21·46	24
25	16·88	22·76	17·69	22·62	18·65	22·45	19·46	22·30	25
26	16·74	23·61	17·54	23·47	18·50	23·29	19·30	23·13	26
27	16·60	24·45	17·39	24·30	18·34	24·12	19·13	23·96	27
28	16·45	25·28	17·24	25·13	18·17	24·95	18·96	24·78	28
29	16·29	26·11	17·07	25·95	18·00	25·76	18·78	25·58	29
30	16·13	26·92	16·91	26·76	17·82	26·56	18·60	26·39	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	50·07		49·74		49·40		49·07		53′
54	51·01		50·68		50·33		50·00		54
55	51·96		51·63		51·26		50·92		55
56	52·90		52·58		52·19		51·85		56
57	53·85	0·94	53·53	0·94	53·13	0·93	52·77	0·92	57
58	54·79		54·47		54·06		53·69		58
59	55·74		55·41		54·99		54·62		59
60	56·69		56·35		55·92		55·54		60
61	57·63		57·29		56·86		56·47		61

Moon's Appt. Decl.	Rio Janeirio.		Havanah.		Bermuda.		Madeira.		Moon's Appt. Decl.
	22° 54′·7 S.		23° 9′·4 N.		32° 19′·0 N.		32° 37′·7 N.		
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	22·06	0·00	22·28	0·00	30·30	0·00	30·56	0·00	0
1	22·05	0·92	22·28	0·92	30·30	0·84	30·56	0·84	1
2	22·04	1·83	22·27	1·83	30·28	1·68	30·54	1·68	2
3	22·03	2·75	22·25	2·74	30·26	2·52	30·52	2·51	3
4	22·00	3·66	22·23	3·66	30·23	3·36	30·49	3·35	4
5	21·97	4·58	22·19	4·57	30·19	4·20	30·45	4·19	5
6	21·94	5·49	22·16	5·48	30·13	5·04	30·39	5·02	6
7	21·89	6·40	22·11	6·39	30·07	5·88	30·33	5·86	7
8	21·84	7·31	22·06	7·30	30·01	6·71	30·26	6·69	8
9	21·78	8·22	22·01	8·20	29·93	7·54	30·19	7·52	9
10	21·72	9·12	21·94	9·10	29·84	8·37	30·10	8·34	10
11	21·65	10·02	21·87	10·00	29·74	9·20	30·00	9·17	11
12	21·57	10·92	21·79	10·90	29·64	10·02	29·89	9·99	12
13	21·49	11·82	21·71	11·80	29·52	10·85	29·78	10·81	13
14	21·40	12·71	21·62	12·69	29·40	11·67	29·65	11·62	14
15	21·30	13·60	21·52	13·57	29·27	12·48	29·52	12·44	15
16	21·20	14·48	21·42	14·45	29·13	13·29	29·38	13·24	16
17	21·09	15·36	21·31	15·33	28·98	14·10	29·23	14·05	17
18	20·98	16·23	21·19	16·20	28·82	14·90	29·07	14·85	18
19	20·85	17·10	21·07	17·07	28·65	15·70	28·90	15·64	19
20	20·73	17·97	20·94	17·93	28·47	16·49	28·72	16·43	20
21	20·59	18·82	20·80	18·79	28·29	17·28	28·53	17·22	21
22	20·45	19·68	20·66	19·64	28·09	18·06	28·34	18·00	22
23	20·30	20·52	20·51	20·49	27·89	18·84	28·13	18·77	23
24	20·15	21·37	20·35	21·33	27·68	19·61	27·92	19·54	24
25	19·99	22·20	20·19	22·16	27·46	20·38	27·70	20·31	25
26	19·82	23·03	20·02	22·99	27·24	21·13	27·47	21·06	26
27	19·74	23·85	19·85	23·81	27·00	21·89	27·23	21·81	27
28	19·47	24·66	19·67	24·62	26·75	22·64	26·98	22·56	28
29	19·29	25·47	19·49	25·42	26·50	23·38	26·73	23·30	29
30	19·10	26·26	19·29	26·22	26·24	24·11	26·47	24·02	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	48·84		48·75		44·83		44·68		53′
54	49·76		49·67		45·68		45·52		54
55	50·68		50·59		46·53		46·36		55
56	51·60		51·51		47·38		47·20		56
57	52·53	0·92	52·43	0·92	48·22	0·85	48·05	0·84	57
58	53·45		53·35		49·07		48·89		58
59	54·37		54·27		49·92		49·73		59
60	55·29		55·19		50·76		50·57		60
61	56·22		56·11		51·60		51·42		61

Moon's Appt. Decl.	Valparaiso. 33° 1′·9 S. A.	Valparaiso. E.	Paramatta. 33° 48′·7 S. A.	Paramatta. E.	Cape of Good Hope. 33° 56′·0 S. A.	Cape of Good Hope. E.	Malta. 35° 53′·9 N. A.	Malta. E.	Moon's Appt. Decl.
0°	30′·90	0′·00	31′·54	0′·00	31′·64	0′·00	33′·24	0′·00	0°
1	30·89	0·83	31·54	0·83	31·64	0·83	33·23	0·81	1
2	30·88	1·67	31·53	1·65	31·62	1·65	33·22	1·61	2
3	30·85	2·50	31·50	2·48	31·60	2·48	33·19	2·42	3
4	30·82	3·34	31·47	3·31	31·57	3·30	33·16	3·22	4
5	30·78	4·17	31·42	4·13	31·52	4·13	33·11	4·03	5
6	30·73	5·00	31·37	4·96	31·47	4·95	33·06	4·83	6
7	30·67	5·83	31·31	5·78	31·41	5·77	32·99	5·63	7
8	30·60	6·66	31·24	6·60	31·34	6·59	32·92	6·43	8
9	30·52	7·48	31·16	7·42	31·25	7·41	32·83	7·23	9
10	30·43	8·31	31·06	8·23	31·16	8·22	32·74	8·03	10
11	30·33	9·13	30·97	9·05	31·06	9·03	32·63	8·82	11
12	30·22	9·95	30·86	9·86	30·95	9·84	32·51	9·61	12
13	30·10	10·76	30·74	10·66	30·83	10·65	32·39	10·40	13
14	29·98	11·57	30·61	11·47	30·70	11·45	32·25	11·18	14
15	29·84	12·38	30·47	12·27	30·57	12·25	32·11	11·96	15
16	29·70	13·18	30·32	13·07	30·42	13·05	31·95	12·74	16
17	29·55	13·99	30·17	13·86	30·26	13·84	31·79	13·51	17
18	29·38	14·78	30·00	14·65	30·09	14·63	31·61	14·28	18
19	29·21	15·57	29·83	15·43	29·92	15·41	31·43	15·05	19
20	29·03	16·36	29·64	16·21	29·74	16·19	31·24	15·81	20
21	28·84	17·14	29·45	16·99	29·54	16·97	31·03	16·57	21
22	28·65	17·92	29·25	17·76	29·34	17·73	30·82	17·32	22
23	28·44	18·69	29·04	18·52	29·13	18·50	30·60	18·06	23
24	28·23	19·46	28·82	19·28	28·91	19·25	30·37	18·80	24
25	28·00	20·22	28·59	20·03	28·68	20·01	30·13	19·54	25
26	27·77	20·97	28·35	20·78	28·44	20·75	29·88	20·26	26
27	27·53	21·72	28·11	21·52	28·19	21·49	29·62	20·99	27
28	27·28	22·46	27·85	22·26	27·94	22·22	29·35	21·70	28
29	27·02	23·19	27·59	22·98	27·68	22·95	29·07	22·41	29
30	26·76	23·92	27·32	23·70	27·40	23·67	28·79	23·11	30
Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	44·48		44·08		44·02		42·98		53′
54	45·32		44·91		44·85		43·79		54
55	46·16		45·74		45·68		44·60		55
56	47·00		46·57		46·51		45·41		56
57	47·83	0·84	47·41	0·83	47·34	0·83	46·23	0·81	57
58	48·67		48·24		48·17		47·04		58
59	49·51		49·07		49·00		47·85		59
60	50·35		49·90		49·83		48·66		60
61	51·19		50·73		50·66		49·47		61

Moon's Appt. Decl.	Gibraltar. 36° 7′·3 N.		Port San Francisco. 37° 47′·8 N.		Palermo. 38° 6′·7 N		Smyrna. 38° 26′·5 N.		Moon's Appt. Decl.
	A.	E.	A.	E.	A.	E.	A.	E.	
°	′	′	′	′	′	′	′	′	°
0	33·42	0·00	34·75	0·00	34·99	0·00	35·25	0·00	0
1	33·41	0·80	34·74	0·79	34·99	0·78	35·24	0·78	1
2	33·40	1·61	34·73	1·57	34·97	1·57	35·23	1·56	2
3	33·37	2·41	34·70	2·36	34·95	2·35	35·20	2·34	3
4	33·34	3·22	34·66	3·15	34·91	3·13	35·16	3·12	4
5	33·29	4·02	34·61	3·93	34·86	3·91	35·12	3·90	5
6	33·24	4·82	34·56	4·71	34·80	4·69	35·06	4·67	6
7	33·17	5·62	34·49	5·50	34·73	5·47	34·99	5·45	7
8	33·09	6·41	34·41	6·28	34·65	6·25	34·91	6·22	8
9	33·01	7·21	34·32	7·06	34·56	7·02	34·82	6·99	9
10	32·91	8·00	34·22	7·83	34·46	7·80	34·71	7·76	10
11	32·81	8·79	34·11	8·60	34·35	8·57	34·60	8·53	11
12	32·69	9·58	33·99	9·38	34·23	9·34	34·48	9·29	12
13	32·56	10·37	33·86	10·14	34·10	10·10	34·35	10·06	13
14	32·43	11·15	33·71	10·91	33·95	10·86	34·20	10·81	14
15	32·28	11·93	33·56	11·67	33·80	11·62	34·05	11·57	15
16	32·12	12·71	33·40	12·43	33·64	12·38	33·88	12·32	16
17	31·96	13·48	33·23	13·18	33·46	13·13	33·71	13·07	17
18	31·78	14·24	33·05	13·94	33·28	13·88	33·53	13·81	18
19	31·60	15·01	32·85	14·68	33·09	14·62	33·33	14·56	19
20	31·40	15·77	32·65	15·42	32·88	15·36	33·12	15·29	20
21	31·20	16·52	32·44	16·16	32·67	16·09	32·91	16·02	21
22	30·99	17·27	32·22	16·89	32·45	16·82	32·68	16·75	22
23	30·76	18·01	31·98	17·62	32·21	17·55	32·45	17·47	23
24	30·53	18·75	31·74	18·34	31·97	18·26	32·20	18·18	24
25	30·29	19·48	31·49	19·06	31·72	18·98	31·95	18·89	25
26	30·04	20·21	31·23	19·77	31·45	19·68	31·68	19·60	26
27	29·78	20·93	30·96	20·47	31·18	20·39	31·41	20·29	27
28	29·51	21·64	30·68	21·17	30·90	21·08	31·12	20·99	28
29	29·23	22·35	30·39	21·86	30·61	21·77	30·83	21·67	29
30	28·94	23·05	30·09	22·55	30·31	22·45	30·53	22·35	30

Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	42·86		41·93		41·75		41·56		53′
54	43·67		42·72		42·54		42·34		54
55	44·48		43·51		43·33		43·13		55
56	45·29		44·30		44·12		43·91		56
57	46·10	0·81	45·10	0·79	44·90	0·79	44·70	0·78	57
58	46·91		45·89		45·69		45·48		58
59	47·72		46·68		46·48		46·27		59
60	48·53		47·47		47·27		47·05		60
61	49·33		48·26		48·05		47·84		61

Moon's Appt. Decl.	Lisbon. 38° 42′·4 N. A.	E.	New York. 40° 42′·8 N. A.	E.	Hobarton. 42° 52′·5 S. A.	E.	Halifax. 44° 39′·4 N. A.	E.	Moon's Appt. Decl.
0°	35′·46	0′·00	36′·99	0′·00	38′·59	0′·00	39′·87	0′·00	0°
1	35·45	0·78	36·98	0·76	38·58	0·73	39·86	0·71	1
2	35·43	1·55	36·97	1·51	38·56	1·46	39·84	1·42	2
3	35·41	2·33	36·94	2·26	38·53	2·19	39·81	2·13	3
4	35·37	3·11	36·90	3·02	38·49	2·92	39·77	2·83	4
5	35·32	3·88	36·85	3·77	38·44	3·65	39·71	3·54	5
6	35·26	4·66	36·78	4·52	38·38	4·37	39·65	4·24	6
7	35·19	5·43	36·71	5·27	38·30	5·10	39·57	4·95	7
8	35·11	6·20	36·63	6·02	38·21	5·82	39·48	5·65	8
9	35·02	6·97	36·53	6·77	38·11	6·54	39·37	6·35	9
10	34·92	7·73	36·43	7·51	38·00	7·26	39·26	7·05	10
11	34·80	8·50	36·31	8·26	37·88	7·98	39·13	7·75	11
12	34·68	9·26	36·18	9·00	37·74	8·70	38·99	8·44	12
13	34·55	10·02	36·04	9·73	37·60	9·41	38·84	9·14	13
14	34·40	10·77	35·89	10·47	37·44	10·12	38·68	9·82	14
15	34·25	11·53	35·73	11·20	37·27	10·83	38·51	10·51	15
16	34·08	12·28	35·55	11·93	37·09	11·53	38·32	11·19	16
17	33·91	13·02	35·37	12·65	36·90	12·23	38·12	11·87	17
18	33·72	13·76	35·18	13·37	36·70	12·93	37·91	12·55	18
19	33·52	14·50	34·97	14·09	36·48	13·62	37·69	13·22	19
20	33·32	15·23	34·76	14·80	36·26	14·31	37·46	13·89	20
21	33·10	15·96	34·53	15·50	36·02	14·99	37·22	14·55	21
22	32·87	16·68	34·29	16·21	35·78	15·67	36·96	15·21	22
23	32·64	17·40	34·05	16·91	35·52	16·35	36·70	15·87	23
24	32·39	18·12	33·79	17·60	35·25	17·02	36·42	16·52	24
25	32·13	18·82	33·52	18·28	34·97	17·68	36·13	17·16	25
26	31·87	19·52	33·24	18·97	34·68	18·34	35·83	17·80	26
27	31·59	20·22	32·96	19·64	34·38	18·99	35·52	18·44	27
28	31·31	20·91	32·66	20·31	34·07	19·64	35·20	19·07	28
29	31·01	21·59	32·35	20·98	33·75	20·28	34·87	19·69	29
30	30·71	22·27	32·03	21·63	33·42	20·92	34·52	20·31	30
Moon's H.P.	**I.**	**Diff.**	**I.**	**Diff.**	**I.**	**Diff.**	**I.**	**Diff.**	**Moon's H.P.**
53′	41·41		40·23		38·90		37·76		53′
54	42·19		40·99		39·63		38·47		54
55	42·97		41·75		40·36		39·18		55
56	43·75		42·51		41·10		39·89		56
57	44·54	0·78	43·27	0·76	41·84	0·73	40·61	0·71	57
58	45·32		44·03		42·57		41·32		58
59	46·10		44·79		43·31		42·03		59
60	46·88		45·55		44·04		42·74		60
61	47·66		46·30		44·77		43·46		61

Table VIII.

Moon's Appt. Decl.	Milan. 45° 28′·0 N. A.	Milan. E.	Paris. 48° 50′ 2 N. A.	Paris. E.	Portsmouth. 50° 48′·0 N. A.	Portsmouth. E.	Greenwich. 51° 28′ 6 N. A.	Greenwich. E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	40·43	0·00	42·71	0·00	43·97	0·00	44·39	0·00	0
1	40·43	0·70	42·70	0·66	43·96	0·63	44·39	0·62	1
2	40·41	1·40	42·68	1·31	43·94	1·26	44·36	1·24	2
3	40·38	2·10	42·65	1·97	43·91	1·89	44·33	1·86	3
4	40·34	2·79	42·61	2·62	43·86	2·52	44·28	2·48	4
5	40·28	3·49	42·55	3·28	43·80	3·15	44·22	3·10	5
6	40·21	4·19	42·48	3·93	43·73	3·77	44·15	3·72	6
7	40·13	4·88	42·39	4·58	43·64	4·40	44·06	4·34	7
8	40·04	5·57	42·29	5·23	43·54	5·02	43·96	4·95	8
9	39·94	6·26	42·18	5·88	43·43	5·65	43·85	5·56	9
10	39·82	6·95	42·06	6·53	43·30	6·27	43·72	6·18	10
11	39·69	7·64	41·93	7·17	43·16	6·89	43·58	6·79	11
12	39·55	8·33	41·78	7·81	43·01	7·50	43·42	7·40	12
13	39·40	9·01	41·62	8·46	42·84	8·12	43·25	8·00	13
14	39·23	9·69	41·44	9·09	42·66	8·73	43·07	8·61	14
15	39·06	10·36	41·26	9·73	42·47	9·34	42·88	9·21	15
16	38·87	11·04	41·06	10·36	42·27	9·95	42·67	9·80	16
17	38·67	11·71	40·84	10·99	42·05	10·55	42·45	10·40	17
18	38·45	12·37	40·62	11·62	41·82	11·15	42·22	10·99	18
19	38·23	13·04	40·38	12·24	41·57	11·75	41·97	11·58	19
20	38·00	13·70	40·13	12·86	41·32	12·35	41·71	12·17	20
21	37·75	14·35	39·87	13·47	41·05	12·94	41·44	12·75	21
22	37·49	15·00	39·60	14·08	40·77	13·52	41·16	13·33	22
23	37·22	15·65	39·31	14·69	40·47	14·10	40·86	13·90	23
24	36·94	16·29	39·02	15·29	40·17	14·68	40·55	14·47	24
25	36·64	16·92	38·71	15·89	39·85	15·26	40·23	15·03	25
26	36·34	17·55	38·39	16·48	39·52	15·83	39·90	15·59	26
27	36·03	18·18	38·06	17·06	39·18	16·39	39·55	16·15	27
28	35·70	18·80	37·71	17·65	38·82	16·95	39·20	16·70	28
29	35·36	19·41	37·36	18·22	38·46	17·50	38·83	17·25	29
30	35·02	20·02	36·99	18·79	38·08	18·05	38·44	17·79	30

Moon's H.P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H.P.
53′	37·23		34·95		33·56		33·07		53′
54	37·93		35·61		34·19		33·70		54
55	38·63		36·27		34·83		34·32		55
56	39·33		36·93		35·46		34·95		56
57	40·04	0·70	37·59	0·66	36·10	0·63	35·57	0·63	57
58	40·74		38·25		36·73		36·20		58
59	41·44		38·91		37·37		36·82		59
60	42·14		39·57		38·00		37·44		60
61	42·85		40·23		38·63		38·07		61

Moon's Appt. Decl.	Oxford. 51° 45′·7 N. A.	Oxford. E.	Cambridge. 52° 12′·9 N. A.	Cambridge. E.	Berlin. 52° 31′·2 N. A.	Berlin. E.	Dublin. 53° 23′·2 N. A.	Dublin. E.	Moon's Appt. Decl.
0°	44·57′	0·00′	44·84′	0·00′	45·03′	0·00′	45·55′	0·00′	0°
1	44·56	0·62	44·84	0·61	45·02	0·61	45·54	0·59	1
2	44·54	1·23	44·82	1·22	45·00	1·21	45·52	1·19	2
3	44·51	1·85	44·78	1·83	44·97	1·82	45·49	1·78	3
4	44·46	2·47	44·74	2·44	44·92	2·42	45·44	2·38	4
5	44·40	3·08	44·67	3·05	44·86	3·03	45·38	2·97	5
6	44·32	3·70	44·60	3·66	44·78	3·63	45·30	3·56	6
7	44·23	4·31	44·51	4·26	44·69	4·24	45·21	4·15	7
8	44·13	4·92	44·41	4·87	44·59	4·84	45·11	4·74	8
9	44·02	5·53	44·29	5·47	44·48	5·44	44·99	5·33	9
10	43·89	6·14	44·16	6·08	44·35	6·04	44·86	5·92	10
11	43·75	6·75	44·02	6·68	44·20	6·63	44·71	6·50	11
12	43·59	7·35	43·86	7·28	44·05	7·23	44·55	7·08	12
13	43·42	7·95	43·70	7·87	43·88	7·82	44·38	7·66	13
14	43·24	8·55	43·51	8·47	43·69	8·41	44·20	8·24	14
15	43·05	9·15	43·32	9·06	43·50	9·00	44·00	8·82	15
16	42·84	9·74	43·11	9·65	43·29	9·58	43·79	9·39	16
17	42·62	10·34	42·89	10·23	43·06	10·16	43·56	9·96	17
18	42·39	10·92	42·65	10·81	42·83	10·74	43·32	10·53	18
19	42·14	11·51	42·40	11·39	42·58	11·32	43·07	11·09	19
20	41·88	12·09	42·14	11·97	42·31	11·89	42·80	11·65	20
21	41·61	12·67	41·87	12·54	42·04	12·46	42·52	12·21	21
22	41·32	13·24	41·58	13·11	41·75	13·02	42·23	12·76	22
23	41·02	13·81	41·28	13·67	41·45	13·58	41·93	13·31	23
24	40·71	14·38	40·97	14·23	41·14	14·14	41·61	13·86	24
25	40·39	14·94	40·64	14·79	40·81	14·69	41·28	14·40	25
26	40·06	15·50	40·31	15·34	40·47	15·24	40·94	14·93	26
27	39·71	16·05	39·96	15·89	40·12	15·78	40·58	15·47	27
28	39·35	16·60	39·60	16·43	39·76	16·32	40·22	15·99	28
29	38·98	17·14	39·22	16·97	39·38	16·85	39·84	16·52	29
30	38·60	17·68	38·84	17·50	39·00	17·38	39·45	17·03	30

Moon's H.P.	Oxford I.	Oxford Diff.	Cambridge I.	Cambridge Diff.	Berlin I.	Berlin Diff.	Dublin I.	Dublin Diff.	Moon's H.P.
53′	32·87		32·54		32·32		31·68		53′
54	33·49		33·15		32·93		32·28		54
55	34·11		33·77		33·54		32·88		55
56	34·73		34·38		34·15		33·48		56
57	35·35	0·62	35·00	0·61	34·75	0·61	34·07	0·60	57
58	35·97		35·61		35·36		34·67		58
59	36·59		36·23		35·97		35·27		59
60	37·21		36·84		36·58		35·87		60
61	37·83		37·45		37·19		36·46		61

Moon's Appt. Decl.	Altona. 53° 32′·7 N. A.	Altona. E.	Durham. 54° 46′·2 N. A.	Durham. E.	Edinburgh. 55° 57′·4 N. A.	Edinburgh. E.	St. Petersburgh. 59° 56′·5 N. A.	St. Petersburgh. E.	Moon's Appt. Decl.
°	′	′	′	′	′	′	′	′	°
0	45·64	0·00	46·36	0·00	47·03	0·00	49·13	0·00	0
1	45·64	0·59	46·35	0·58	47·02	0·56	49·12	0·50	1
2	45·62	1·18	46·33	1·15	47·00	1·12	49·10	1·00	2
3	45·58	1·78	46·29	1·72	46·96	1.67	49·06	1·50	3
4	45·53	2·37	46·24	2·30	46·91	2·23	49·01	2·00	4
5	45·47	2·96	46·18	2·87	46·85	2·79	48·95	2·49	5
6	45·39	3·55	46·11	3·44	46·77	3·34	48·86	2·99	6
7	45·30	4·14	46·01	4·02	46·68	3·90	48·77	3·49	7
8	45·20	4·72	45·91	4·59	46·57	4·45	48·65	3·98	8
9	45·08	5·31	45·79	5·15	46·45	5·00	48·53	4·48	9
10	44·95	5·89	45·65	5·72	46·31	5·55	48·39	4·97	10
11	44·81	6·48	45·51	6·29	46·16	6·10	48·23	5·46	11
12	44·65	7·06	45·34	6·85	46·00	6·65	48·06	5·95	12
13	44·47	7·63	45·17	7·41	45·82	7·19	47·87	6·44	13
14	44·29	8·21	44·98	7·97	45·63	7·74	47·67	6·92	14
15	44·09	8·78	44·78	8·53	45·42	8·28	47·46	7·41	15
16	43·88	9·36	44·56	9·08	45·20	8·82	47·23	7·89	16
17	43·65	9·92	44·33	9·63	44·97	9·35	46·99	8·37	17
18	43·41	10·49	44·09	10·18	44·73	9·88	46·73	8·84	18
19	43·16	11·05	43·83	10·73	44·47	10·41	46·46	9·32	19
20	42·89	11·61	43·56	11·27	44·19	10·94	46·17	9·79	20
21	42·61	12·16	43·28	11·81	43·90	11·46	45·87	10·26	21
22	42·32	12·71	42·98	12·34	43·60	11·98	45·56	10·72	22
23	42·02	13·26	42·67	12·88	43·29	12·50	45·23	11·18	23
24	41·70	13·81	42·35	13·40	42·96	13·00	44·88	11·64	24
25	41·37	14·34	42·01	13·93	42·62	13·52	44·53	12·10	25
26	41·02	14·88	41·66	14·45	42·27	14·02	44·16	12·55	26
27	40·67	15·41	41·30	14·96	41 90	14·52	43·78	12·99	27
28	40·30	15·93	40·93	15·47	41·52	15·01	43·38	13·44	28
29	39·92	16·45	40·54	15·98	41·13	15·50	42·97	13·87	29
30	39·53	16·97	40·15	16·48	40·73	15·99	42·55	14·31	30

Moon's H. P.	I.	Diff.	I.	Diff.	I.	Diff.	I.	Diff.	Moon's H. P.
53′	31·56		30·64		29·74		26·61		53′
54	32·15		31·22		30·30		27·11		54
55	32·75		31·80		30·86		27·61		55
56	33·34		32·38		31·42		28·11		56
57	33·94	0·59	32·95	0·58	31·98	0·56	28·62	0·50	57
58	34·53		33·53		32·54		29·12		58
59	35·13		34·11		33·10		29·62		59
60	35·73		34·69		33·66		30·12		60
61	36·32		35·26		34·22		30·63		61

Tabular Value of A or E.	Moon's Horizontal Parallax.				Tabular Value of A or E.	Moon's Horizontal Parallax.			
	53′·0.	53′·5.	54′·0.	54′·5.		53′·0.	53′·5.	54′·0.	54′·5.
0·50	0·46	0·47	0·47	0·48	26·50	24·64	24·87	25·11	25·34
1·00	0·93	0·94	0·95	0·96	27·00	25·10	25·34	25·58	25·81
1·50	1·39	1·41	1·42	1·43	27·50	25·57	25·81	26·05	26·29
2·00	1·86	1·88	1·89	1·91	28·00	26·03	26·28	26·53	26·77
2·50	2·32	2·35	2·37	2·39	28·50	26·50	26·75	27·00	27·25
3·00	2·79	2·82	2·84	2·87	29·00	26·96	27·22	27·47	27·73
3·50	3·25	3·29	3·32	3·35	29·50	27·43	27·69	27·95	28·20
4·00	3·72	3·75	3·79	3·82	30·00	27·89	28·16	28·42	28·68
4·50	4·18	4·22	4·26	4·30	30·50	28·36	28·63	28·89	29·16
5·00	4·65	4·69	4·74	4·78	31·00	28·82	29·10	29·37	29·64
5·50	5·11	5·16	5·21	5·26	31·50	29·29	29·56	29·84	30·12
6·00	5·58	5·63	5·68	5·74	32·00	29·75	30·03	30·32	30·59
6·50	6·04	6·10	6·16	6·21	32·50	30·22	30·50	30·79	31·07
7·00	6·51	6·57	6·63	6·69	33·00	30·68	30·97	31·26	31·55
7·50	6·97	7·04	7·11	7·17	33·50	31·15	31·44	31·74	32·03
8·00	7·44	7·51	7·58	7·65	34·00	31·61	31·91	32·21	32·51
8·50	7·90	7·98	8·05	8·13	34·50	32·08	32·38	32·68	32·99
9·00	8·37	8·45	8·53	8·60	35·00	32·54	32·85	33·16	33·46
9·50	8·83	8·92	9·00	9·08	35·50	33·01	33·32	33·63	33·94
10·00	9·30	9·39	9·47	9·56	36·00	33·47	33·79	34·11	34·42
10·50	9·76	9·85	9·95	10·04	36·50	33·94	34·26	34·58	34·90
11·00	10·23	10·32	10·42	10·52	37·00	34·40	34·73	35·05	35·38
11·50	10·69	10·79	10·89	11·00	37·50	34·87	35·20	35·53	35·85
12·00	11·16	11·26	11·37	11·47	38·00	35·33	35·67	36·00	36·33
12·50	11·62	11·73	11·84	11·95	38·50	35·80	36·14	36·47	36·81
13·00	12·09	12·20	12·32	12·43	39·00	36·26	36·61	36·95	37·29
13·50	12·55	12·67	12·79	12·91	39·50	36·73	37·07	37·42	37·77
14·00	13·02	13·14	13·26	13·39	40·00	37·19	37·54	37·90	38·24
14·50	13·48	13·61	13·74	13·86	40·50	37·66	38·01	38·37	38·72
15·00	13·95	14·08	14·21	14·34	41·00	38·12	38·48	38·84	39·20
15·50	14·41	14·55	14·68	14·82	41·50	38·59	38·95	39·32	39·68
16·00	14·88	15·02	15·16	15·30	42·00	39·05	39·42	39·79	40·16
16·50	15·34	15·49	15·63	15·78	42·50	39·52	39·89	40·26	40·63
17·00	15·81	15·96	16·11	16·25	43·00	39·98	40·36	40·74	41·11
17·50	16·27	16·42	16·58	16·73	43·50	40·45	40·83	41·21	41·59
18·00	16·74	16·89	17·05	17·21	44·00	40·91	41·30	41·68	42·07
18·50	17·20	17·36	17·53	17·69	44·50	41·38	41·77	42·16	42·55
19·00	17·67	17·83	18·00	18·17	45·00	41·84	42·24	42·63	43·02
19·50	18·13	18·30	18·47	18·64	45·50	42·31	42·71	43·11	43·50
20·00	18·60	18·77	18·95	19·12	46·00	42·77	43·18	43·58	43·98
20·50	19·06	19·24	19·42	19·60	46·50	43·24	43·65	44·05	44·46
21·00	19·53	19·71	19·89	20·08	47·00	43·70	44·11	44·53	44·94
21·50	19·99	20·18	20·37	20·56	47·50	44·17	44·58	45·00	45·41
22·00	20·46	20·65	20·84	21·03	48·00	44·63	45·05	45·48	45·89
22·50	20·92	21·12	21·32	21·51	48·50	45·10	45·52	45·95	46·37
23·00	21·39	21·59	21·79	21·99	49·00	45·56	45·99	46·42	46·85
23·50	21·85	22·06	22·26	22·47	49·50	46·03	46·46	46·89	47·33
24·00	22·32	22·53	22·74	22·95	50·00	46·49	46·93	47·37	47·80
24·50	22·78	23·00	23·21	23·42	50·50	46·96	47·40	47·84	48·28
25·00	23·24	23·46	23·68	23·90	51·00	47·42	47·87	48·32	48·76
25·50	23·71	23·93	24·16	24·38	51·50	47·89	48·34	48·79	49·24
26·00	24·18	24·40	24·63	24·86	52·00	48·35	48·81	49·26	49·72

Tabular Value of A or E.	Moon's Horizontal Parallax. 55′·0.	55′·5.	56′·0.	56′·5.	Tabular Value of A or E.	Moon's Horizontal Parallax. 55′·0.	55′·5.	56′·0.	56′·5.
0·50	0·48	0·49	0·49	0·50	26·50	25·57	25·80	26·03	26·27
1·00	0·96	0·97	0·98	0·99	27·00	26·05	26·29	26·53	26·76
1·50	1·45	1·46	1·47	1·49	27·50	26·53	26·78	27·02	27·26
2·00	1·93	1·95	1·96	1·98	28·00	27·02	27·26	27·51	27·75
2·50	2·41	2·43	2·46	2·48	28·50	27·50	27·75	28·00	28·25
3·00	2·89	2·92	2·95	2·97	29·00	27·98	28·24	28·49	28·74
3·50	3·38	3·41	3·44	3·47	29·50	28·46	28·72	28·98	29·24
4·00	3·86	3·89	3·93	3·96	30·00	28·95	29·21	29·47	29·74
4·50	4·34	4·38	4·42	4·46	30·50	29·43	29·70	29·97	30·23
5·00	4·82	4·87	4·91	4·96	31·00	29·91	30·18	30·46	30·73
5·50	5·31	5·36	5·40	5·45	31·50	30·39	30·67	30·95	31·22
6·00	5·79	5·84	5·89	5·95	32·00	30·88	31·16	31·44	31·72
6·50	6·27	6·33	6·39	6·44	32·50	31·36	31·64	31·93	32·21
7·00	6·75	6·82	6·88	6·94	33·00	31·84	32·13	32·42	32·71
7·50	7·24	7·30	7·37	7·43	33·50	32·32	32·62	32·91	33·20
8·00	7·72	7·79	7·86	7·93	34·00	32·81	33·11	33·40	33·70
8·50	8·20	8·28	8·35	8·43	34·50	33·29	33·59	33·89	34·19
9·00	8·68	8·76	8·84	8·92	35·00	33·77	34·08	34·39	34·69
9·50	9·17	9·25	9·33	9·42	35·50	34·25	34·56	34·88	35·19
10·00	9·65	9·74	9·82	9·91	36·00	34·74	35·05	35·37	35·68
10·50	10·13	10·22	10·32	10·41	36·50	35·22	35·54	35·86	36·18
11·00	10·61	10·71	10·81	10·90	37·00	35·70	36·02	36·35	36·67
11·50	11·10	11·20	11·30	11·40	37·50	36·18	36·51	36·84	37·17
12·00	11·58	11·68	11·79	11·89	38·00	36·67	37·00	37·33	37·67
12·50	12·06	12·17	12·28	12·39	38·50	37·15	37·49	37·83	38·16
13·00	12·54	12·66	12·77	12·89	39·00	37·63	37·97	38·32	38·66
13·50	13·03	13·14	13·26	13·38	39·50	38·11	38·46	38·81	39·15
14·00	13·51	13·63	13·75	13·88	40·00	38·60	38·95	39·30	39·65
14·50	13·99	14·12	14·25	14·37	40·50	39·08	39·43	39·79	40·14
15·00	14·47	14·60	14·74	14·87	41·00	39·56	39·92	40·28	40·64
15·50	14·96	15·09	15·23	15·36	41·50	40·04	40·41	40·77	41·13
16·00	15·44	15·58	15·72	15·86	42·00	40·53	40·90	41·26	41·63
16·50	15·92	16·07	16·21	16·35	42·50	41·01	41·38	41·76	42·13
17·00	16·40	16·55	16·70	16·85	43·00	41·49	41·87	42·25	42·62
17·50	16·89	17·04	17·19	17·35	43·50	41·97	42·36	42·74	43·12
18·00	17·37	17·53	17·68	17·84	44·00	42·46	42·84	43·23	43·61
18·50	17·85	18·01	18·18	18·34	44·50	42·94	43·33	43·72	44·11
19·00	18·33	18·50	18·67	18·83	45·00	43·42	43·82	44·21	44·60
19·50	18·82	18·99	19·16	19·33	45·50	43·90	44·30	44·70	45·10
20·00	19·30	19·47	19·65	19·82	46·00	44·39	44·79	45·19	45·59
20·50	19·78	19·96	20·14	20·32	46·50	44·87	45·28	45·68	46·09
21·00	20·26	20·45	20·63	20·82	47·00	45·35	45·76	46·18	46·59
21·50	20·75	20·93	21·12	21·31	47·50	45·83	46·25	46·67	47·08
22·00	21·23	21·42	21·61	21·81	48·00	46·32	46·74	47·16	47·58
22·50	21·71	21·91	22·11	22·30	48·50	46·80	47·22	47·65	48·07
23·00	22·19	22·39	22·60	22·80	49·00	47·28	47·71	48·14	48·57
23·50	22·68	22·88	23·09	23·29	49·50	47·76	48·20	48·63	49·06
24·00	23·16	23·37	23·58	23·79	50·00	48·24	48·68	49·12	49·56
24·50	23·64	23·85	24·07	24·28	50·50	48·73	49·17	49·61	50·06
25·00	24·12	24·34	24·56	24·78	51·00	49·21	49·66	50·11	50·55
25·50	24·61	24·83	25·05	25·28	51·50	49·69	50·14	50·60	51·05
26·00	25·09	25·31	25·54	25·77	52·00	50·18	50·63	51·09	51·54

Tabular Value of A or E.	Moon's Horizontal Parallax.				Tabular Value of A or E.	Moon's Horizontal Parallax.			
	57′·5.	58′·0.	58′·5.	59′·0.		57′·5.	58′·0.	58′·5.	59′·0.
0·50	0·50	0·51	0·51	0·52	26·50	26·73	26·96	27·20	27·43
1·00	1·01	1·02	1·03	1·04	27·00	27·24	27·47	27·71	27·95
1·50	1·51	1·53	1·54	1·55	27·50	27·74	27·98	28·22	28·46
2·00	2·02	2·03	2·05	2·07	28·00	28·25	28·49	28·74	28·98
2·50	2·52	2·54	2·57	2·59	28·50	28·75	29·00	29·25	29·50
3·00	3·03	3·05	3·08	3·11	29·00	29·26	29·51	29·76	30·02
3·50	3·53	3·56	3·59	3·62	29·50	29·76	30·02	30·2[illegible]	30·54
4·00	4·04	4·07	4·11	4·14	30·00	30·26	30·52	30·79	31·06
4·50	4·54	4·58	4·62	4·66	30·50	30·77	31·03	31·30	31·57
5·00	5·04	5·09	5·13	5·18	31·00	31·27	31·54	31·81	32·09
5·50	5·55	5·60	5·64	5·69	31·50	31·78	32·05	32·33	32·61
6·00	6·05	6·10	6·16	6·21	32·00	32·28	32·56	32·84	33·12
6·50	6·56	6·61	6·67	6·73	32·50	32·79	33·07	33·35	33·64
7·00	7·06	7·12	7·18	7·25	33·00	33·29	33·58	33·87	34·16
7·50	7·57	7·63	7·70	7·76	33·50	33·80	34·09	34·38	34·68
8·00	8·07	8·14	8·21	8·28	34·00	34·30	34·60	34·89	35·19
8·50	8·57	8·65	8·72	8·80	34·50	34·80	35·10	35·41	35·71
9·00	9·08	9·16	9·24	9·32	35·00	35·31	35·61	35·92	36·23
9·50	9·58	9·67	9·75	9·83	35·50	35·81	36·12	36·43	36·74
10·00	10·09	10·17	10·26	10·35	36·00	36·32	36·63	36·95	37·26
10·50	10·59	10·68	10·78	10·87	36·50	36·82	37·14	37·46	37·78
11·00	11·10	11·19	11·29	11·39	37·00	37·33	37·65	37·97	38·30
11·50	11·60	11·70	11·80	11·90	37·50	37·83	38·16	38·48	38·82
12·00	12·11	12·21	12·32	12·42	38·00	38·33	38·67	39·00	39·33
12·50	12·61	12·72	12·83	12·94	38·50	38·84	39·17	39·51	39·84
13·00	13·11	13·23	13·34	13·46	39·00	39·34	39·68	40·03	40·37
13·50	13·62	13·74	13·85	13·97	39·50	39·85	40·19	40·54	40·89
14·00	14·12	14·25	14·37	14·49	40·00	40·35	40·70	41·05	41·40
14·50	14·63	14·75	14·88	15·01	40·50	40·86	41·21	41·56	41·92
15·00	15·13	15·26	15·39	15·53	41·00	41·36	41·72	42·08	42·44
15·50	15·64	15·77	15·91	16·04	41·50	41·86	42·23	42·59	42·96
16·00	16·14	16·28	16·42	16·56	42·00	42·37	42·74	43·10	43·47
16·50	16·65	16·79	16·93	17·08	42·50	42·87	43·24	43·62	43·99
17·00	17·15	17·30	17·45	17·60	43·00	43·38	43·75	44·13	44·51
17·50	17·65	17·81	17·96	18·11	43·50	43·88	44·26	44·64	45·03
18·00	18·16	18·31	18·47	18·63	44·00	44·39	44·77	45·16	45·54
18·50	18·66	18·82	18·99	19·15	44·50	44·89	45·28	45·67	46·06
19·00	19·17	19·33	19·50	19·67	45·00	45·40	45·79	46·18	46·58
19·50	19·67	19·84	20·01	20·18	45·50	45·90	46·30	46·70	47·10
20·00	20·18	20·35	20·53	20·70	46·00	46·40	46·81	47·21	47·61
20·50	20·68	20·86	21·04	21·22	46·50	46·91	47·32	47·72	48·13
21·00	21·19	21·37	21·55	21·74	47·00	47·41	47·82	48·24	48·65
21·50	21·69	21·88	22·07	22·25	47·50	47·92	48·33	48·75	49·17
22·00	22·19	22·39	22·58	22·77	48·00	48·42	48·84	49·26	49·68
22·50	22·70	22·89	23·09	23·29	48·50	48·93	49·35	49·78	50·20
23·00	23·20	23·40	23·60	23·81	49·00	49·43	49·86	50·29	50·72
23·50	23·71	23·91	24·12	24·32	49·50	49·94	50·37	50·80	51·24
24·00	24·21	24·42	24·63	24·84	50·00	50·44	50·87	51·31	51·76
24·50	24·72	24·93	25·14	25·36	50·50	50·94	51·38	51·83	52·27
25·00	25·22	25·44	25·66	25·88	51·00	51·45	51·89	52·34	52·79
25·50	25·72	25·95	26·17	26·39	51·50	51·95	52·40	52·85	53·31
26·00	26·23	26·46	26·68	26·91	52·00	52·46	52·91	53·37	53·82

TABLE IX.

Tabular Value of A or E.	Moon's Horizontal Parallax.				Tabular Value of A or E.	Moon's Horizontal Parallax.			
	59′·5.	60′·0.	60′·5.	61′·0.		59′·5.	60′·0.	60′·5.	61′·0.
0·50	0·52	0·53	0·53	0·54	26·50	27·66	27·89	28·13	28·36
1·00	1·04	1·05	1·06	1·07	27·00	28·18	28·42	28·66	28·90
1·50	1·57	1·58	1·59	1·61	27·50	28·70	28·95	29·19	29·43
2·00	2·09	2·11	2·12	2·14	28·00	29·23	29·47	29·72	29·96
2·50	2·61	2·63	2·65	2·68	28·50	29·75	30·00	30·25	30·50
3·00	3·13	3·16	3·18	3·21	29·00	30·27	30·53	30·78	31·04
3·50	3·65	3·68	3·71	3·75	29·50	30·79	31·05	31·31	31·57
4·00	4·18	4·21	4·25	4·28	30·00	31·31	31·58	31·84	32·11
4·50	4·70	4·74	4·78	4·82	30·50	31·84	32·11	32·37	32·64
5·00	5·22	5·26	5·31	5·35	31·00	32·36	32·63	32·90	33·18
5·50	5·74	5·79	5·84	5·89	31·50	32·88	33·16	33·43	33·71
6·00	6·26	6·32	6·37	6·42	32·00	33·40	33·68	33·96	34·25
6·50	6·78	6·84	6·90	6·96	32·50	33·92	34·21	34·50	34·78
7·00	7·31	7·37	7·43	7·49	33·00	34·45	34·74	35·03	35·32
7·50	7·83	7·89	7·96	8·03	33·50	34·97	35·26	35·56	35·85
8·00	8·35	8·42	8·49	8·56	34·00	35·49	35·79	36·09	36·39
8·50	8·87	8·95	9·02	9·10	34·50	36·01	36·32	36·62	36·92
9·00	9·39	9·47	9·55	9·63	35·00	36·53	36·84	37·15	37·46
9·50	9·92	10·00	10·08	10·17	35·50	37·05	37·37	37·68	37·99
10·00	10·44	10·53	10·61	10·70	36·00	37·58	37·89	38·21	38·53
10·50	10·96	11·05	11·14	11·24	36·50	38·10	38·42	38·74	39·06
11·00	11·48	11·58	11·68	11·77	37·00	38·62	38·95	39·27	39·60
11·50	12·00	12·11	12·21	12·31	37·50	39·14	39·47	39·80	40·13
12·00	12·53	12·63	12·74	12·84	38·00	39·66	40·00	40·33	40·67
12·50	13·05	13·16	13·27	13·38	38·50	40·19	40·53	40·86	41·20
13·00	13·57	13·68	13·80	13·91	39·00	40·71	41·05	41·39	41·74
13·50	14·09	14·21	14·33	14·45	39·50	41·23	41·58	41·93	42·27
14·00	14·61	14·74	14·86	14·98	40·00	41·75	42·10	42·46	42·81
14·50	15·14	15·26	15·39	15·52	40·50	42·27	42·63	42·99	43·34
15·00	15·66	5·79	15·92	16·05	41·00	42·80	43·16	43·52	43·88
15·50	16·18	16·32	16·45	16·59	41·50	43·32	43·68	44·05	44·41
16·00	16·70	16·84	16·98	17·12	42·00	43·84	44·21	44·58	44·95
16·50	17·22	17·37	17·51	17·66	42·50	44·36	44·74	45·11	45·48
17·00	17·75	17·89	18·04	18·19	43·00	44·88	45·26	45·64	46·02
17·50	18·27	18·42	18·57	18·73	43·50	45·41	45·79	46·17	46·55
18·00	18·79	18·95	19·11	19·26	44·00	45·93	46·32	46·70	47·09
18·50	19·31	19·47	19·64	19·80	44·50	46·45	46·84	47·23	47·62
19·00	19·83	20·00	20·17	20·33	45·00	46·97	47·37	47·76	48·16
19·50	20·35	20·53	20·70	20·87	45·50	47·49	47·89	48·29	48·69
20·00	20·88	21·05	21·23	21·40	46·00	48·02	48·42	48·82	49·23
20·50	21·40	21·58	21·76	21·94	46·50	48·54	48·95	49·36	49·76
21·00	21·92	22·11	22·29	22·47	47·00	49·06	49·47	49·89	50·30
21·50	22·44	22·63	22·82	23·01	47·50	49·58	50·00	50·42	50·83
22·00	22·96	23·16	23·35	23·54	48·00	50·10	50·52	50·95	51·37
22·50	23·49	23·68	23·88	24·08	48·50	50·62	51·05	51·48	51·90
23·00	24·01	24·21	24·41	24·61	49·00	51·15	51·58	52·01	52·44
23·50	24·53	24·74	24·94	25·15	49·50	51·67	52·11	52·54	52·97
24·00	25·05	25·26	25·47	25·68	50·00	52·19	52·63	53·07	53·51
24·50	25·57	25·79	26·00	26·22	50·50	52·71	53·16	53·60	54·04
25·00	26·10	26·31	26·53	26·75	51·00	53·24	53·68	54·13	54·58
25·50	26·62	26·84	27·07	27·29	51·50	53·76	54·21	54·66	55·11
26·00	27·14	27·37	27·60	27·82	52·00	54·28	54·74	55·19	55·65

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